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> "*To the solid ground*
> *Of Nature trusts the mind which builds for aye.*"—WORDSWORTH.

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A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

SATURDAY, JANUARY 2, 1926.

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Scientific Worthies.

XLIV.—ALBERT ABRAHAM MICHELSON.

THE co-operation of members of the English-speaking race is heartily welcome in many departments of human activity, some of them presumably more important even than the pursuit of science. But to us who are engaged in that study, the brilliant results obtained of late years in the United States, and the friendly co-operation existing between that country and the different parts of the British Empire, are a suitable subject of felicitation; and I am privileged to write an article in appreciation of the work of one of the most distinguished physicists in the world, the circumstances of whose normal life I understand to be as follows:

Albert Abraham Michelson was born in Strelno, Poland, on December 19, 1852. In 1854 his parents migrated to the United States. After emerging from High School in San Francisco, young Michelson was appointed to the Naval Academy, from which he graduated in 1873, and two years later became instructor in physics and chemistry under Admiral Sampson, continuing this work until 1879. After a year in the Nautical Almanac Office at Washington, Michelson, now an ensign, went abroad for further study at the Universities of Berlin and Heidelberg, and at the Collège de France and the École Polytechnique in Paris. Upon his return to the United States in 1883 he became professor of physics in the Case School of Applied Science, Cleveland, Ohio; whence, after six years, he was called to Clark University, where he remained as professor until 1892, when the University of Chicago opened its doors. Prof. Michelson went to this new institution as professor of physics and head of the department, a position which he still holds. In June 1925 he was honoured by being appointed to the first of the Distinguished Service Professorships made possible by the new development programme of the University.

It was while he was at Cleveland that Prof. Michelson collaborated with Prof. Morley in their joint experiment; and it may have been for the purpose of that experiment that he invented his particular form of interferometer, with the to-and-fro beams at right angles. Later, he applied it in Paris to the determination of the metre, with an estimated accuracy of about one part in two million.

During the World War, Prof. Michelson re-entered the Naval Service with the rank of Lieutenant-Commander, giving his entire time to seeking new devices for naval use, especially a range-finder, which became part of the U.S. Navy Equipment.

So recently as 1924 he undertook a very accurate determination of the velocity of light, using Mount Wilson and San Antonio, 22 miles apart, as the stations. It is believed that he intends to continue this with a base-line 90 miles long, so as to obtain this great fundamental constant with extreme accuracy.

A Nobel Prize was awarded to Prof. Michelson in 1907, the first American to get one for science; and the Copley Medal, the most distinguished honour of the Royal Society of London, was awarded him in the same year.

The gold medal of the Royal Astronomical Society was presented to Prof. Michelson on February 9, 1923; and the compact exposition of the reasons for that award by the president, Prof. Eddington, on that occasion will be found in NATURE, vol. 111, p. 240.

As an expounder of scientific progress it is interesting to read Michelson's address given as retiring president of the American Association for the Advancement of Science, which fortunately has been reproduced in NATURE of January 11, 1912 (vol. 88, p. 362). It covers a lot of ground and the work of many people; and one characteristic of it is the slight emphasis on his own name in connexion with his own work.

Let us see if we can obtain some idea, not indeed of the whole scope of his work, but of some of the salient and outstanding features of it.

Michelson has touched on many departments of physics, but in optics, the highest optics, he excels. In this subject he can be regarded as the most fertile and brilliant disciple of the late Lord Rayleigh, for his inventions are based on a thorough assimilation of the principles of diffraction, interference, and resolving power; and his great practical achievements are the outcome of this knowledge. In this appreciation a reminder of some of the salient features of that work must be appropriate. But his papers cover far more than general principles; they enter into minute details, as is always necessary when theory has to be translated into experiment and instrumental construction. He has been happy in having at his command the possibilities of equipment provided by enlightened citizens of the United States of America; he has been aided by the singular skill of some instrument-makers both in the States and in Great Britain; but without a thorough grasp of theory his ingenious designs would have been impossible.

Michelson seems to have a special instinct for all phenomena connected with the interference of light, with a taste for exact measurement surpassed by none in this particular region. The interferometer with which he began became in his hands much more than an interferometer. He applied it to the determination of the standard metre in terms of the wave-length of light, with exact results which will enable remote posterity millions of years hence to reconstruct, if they want to, the standard measures in vogue at this day. He applied it also to analyse the complex structure of spectrum lines, and with remarkable completeness to determine the shape and size of invisible objects, such as to ordinary vision, however much aided by telescopic power, will probably remain mere points of light. NATURE is read by many other than physicists, and a rough general idea of how these things were accomplished may be welcomed

The kind of interferometer dependent on the use of a semi-transparent plate was begun so long ago as 1859 by Fizeau, who thus split a beam of light into two halves, and with the aid of auxiliary silvered mirrors sent the beams round a circuit along identical paths in opposite directions, so as to become reunited at their point of separation. Thus, by alternate concurrences and oppositions of phase, the illumination was redistributed into bands of remarkable brilliance, which bands would shift in position if any cause accelerated one of the half beams and retarded the other.

Michelson modified this arrangement by altering the angle of the auxiliary mirrors, and setting them perpendicular to the light, so as not to send the two beams round a contour, but to reflect each back upon itself. Each half-beam then makes a to-and-fro journey along its own path, the interference fringes being produced, as before, when the beams reunite at their point of initial separation at the end of their independent journeys. The accidents which can happen to such separated beams are of a different character from those operative in the Fizeau arrangement, and it becomes a different instrument.

If we begin with the two paths equal; noting the position of the fringes by a micrometric device, and then gradually lengthen one of the paths by making its perpendicular mirror retreat, the bands will shift so as to interchange bright for dark when the mirror has retreated a quarter-wave length—which, of course, is an exceedingly small amount. If, by a screw motion, we make the mirror gradually move backwards, an eye at the micrometer will see the bands sailing or floating past, in such a way that their passage can be counted; and we can thereby determine how many wave-lengths the mirror has retreated. We might thus cautiously move it back a centimetre, or even a decimetre, and might then, by ingenious devices and different standard gauges of length, gradually extend the range virtually to as much as a metre: thus counting with extreme precision, and to a small fraction, the number of waves in that length,—using, of course, very homogeneous light, such as is given by a line in the spectrum of cadmium or mercury, or other monatomic substance emitting a simple kind of light.

Now suppose the source of light is not simple: suppose instead of being a single line, it is a double one. Then what will be the effect? The wave-length of the two lines is slightly different. With some adjustments the interference bands may agree in position, so that they are clear and plainly visible: with other adjustments the bright parts of one set may overlap or be superposed upon the dark parts of the other; thus restoring a uniform illumination, and making the bands disappear. A further adjustment in the same direction will cause them to reappear again, and so on periodically. By studying these variations of visibility, and plotting a curve to represent them, after the manner of Rayleigh (see his "Investigations in Optics," *Phil. Mag.*, 1879 and 1880, or Paper Number 62, in vol. i. of his "Collected Scientific Papers"), the nature of the source can be specified with precision, and the relative intensity of the components of the double or multiple source ascertained.

Perhaps the easiest way of getting a general idea of the process is to employ a very simple interference instrument, such as two parallel slits in a card, mounted in a tube like a taper-holder, to which the eye is applied, and then look at a fine line of light like a luminous hair. Interference bands will be seen, caused by the meeting and overlapping of the beams which have come through the two slits. (Lord Rayleigh describes such an easily-made and popular instrument in vol. iv. of the "Collected Papers," p. 76.) Now imagine the source of light shifted parallel to itself, through a distance which when multiplied by a reducing fraction (the ratio of the distance between the slits to their distance from the source) will equal half a wave-length of light. The bands will now look the same as before, but the bright bands will be in the dark bands' places; thus indicating the amount which corresponds to a half wave-length shift. Next, imagine a precisely similar source placed in the original position, and look at the two together. Each will give its own set of bands, but no bands will be visible, because the bright parts of the one will blot out the dark parts of the other. Separate the two sources a little more, or bring them a little nearer together, and in either case the bands will reappear.

We may next proceed to consider what happens when, instead of the two simple sources of light, a square or oblong patch of light is looked at, filling up the space between the two positions. The thing is now becoming a little more complicated, and a numerical factor will have to be introduced depending on the shape of the source of light. It need not be an oblong; it might be a triangular patch, or a circular disc, or any other simple shape. Michelson made a serious study of what would happen for all manner of luminous apertures, and found that a numerical factor could be introduced appropriate to each simple shape, and drew the visibility curve to be expected under the various conditions. This paper will be found in the *Phil. Mag.* for April 1891; and in September 1892 his later paper applied the curves to determine the peculiarities of spectrum lines employed as the source of light.

Before that, however, Michelson had realised that on Rayleigh's principles the resolving power of a telescope could be indefinitely increased by using it to form, not an ordinary image of an object, but the diffraction or interference pattern of such an object.

An early paper by Lord Rayleigh on "The Resolving Power of Spectroscopes," in which the main theory is given, is in the *Phil. Mag.* for March 1874. (See also vol. i. of "Collected Papers," pp. 316, 420, and 424.)

Early in the century that remarkable genius, Thomas Young, had devised what he called an "eriometer" for measuring the size even of very minute granules by their diffraction pattern,—for example, the rings of the halo formed by such a substance as lycopodium. Rayleigh suggested an extension of this method in his "Encyclopædia Britannica" article, "Wave Theory," where he gave the theory of different apertures, and refers to previous workers in France and elsewhere. (Paper Number 148 in vol. iii. of "Collected Papers.")

Michelson pursued the subject into great detail; and in a magnificent paper in the *Phil. Mag.* of July 1890 he suggested the application of interference methods to astronomy. He knew well that the resolving power of a telescope depended on the diameter of its aperture, and that the formation of an image was essentially an interference phenomenon; the minuteness of a point image, and therefore the clearness of definition, depending on the size of the object-glass. But he pointed out that if the aperture was limited to slits at opposite edges—so that no actual image anything like the object would be formed, but only the interference bands which the beams from the two slits could produce—a study of those bands would enable us to infer about the source of light very much more than we could get by looking at its image. For example, suppose it was a close double star, and suppose the slits over the object-glass were movable, so that they could be approached nearer together, or separated the whole distance of the aperture apart. A gradual separation of the slits would now cause the fringes to go through periods of visibility and invisibility; and the first disappearance of the fringes would tell us that the distance apart of the two components of the star (multiplied by the distance between the slits and divided by the distance of the star) would equal half a wave-length of light. The two components might be far too near together ever to be seen separately, and yet we could infer that the star was a double one; and by further attention to the visibility curve we could infer the relative brightness of the two components and their position relative to our line of sight.

Furthermore, if, instead of looking at a star, we turned the slit-provided telescope on a planet with a disc too small for ordinary measurement, the size of that disc could be estimated from the behaviour of the interference fringes produced by its light in a suitable interferometer, or by the telescope converted into one.

Michelson begins this 1890 paper thus:

> "In a recent paper on 'Measurement by Light-waves' it was shown that the limitation of the effective portions of an objective to the extreme ends of a diameter converted the instrument into a refractometer; and although definition and resolution are thereby sacrificed, the accuracy may be increased ten to fifty fold.
>
> "The simplest way of effecting this in the case of a telescope is to provide the cap of the objective with two slits adjustable in width and distance apart. If such a combination be focussed on a star, then, instead of an image of the star, there will be a series of coloured interference-bands with white centre, the bands being arranged at equal distances apart and parallel to the two slits The position of the central white fringe can be marked from ten to fifty times as accurately as can the centre of the telescopic image of the star.
>
> "One of the most promising applications of the method is the measurement of the angular magnitudes of small sources of light."

Michelson further realises, even at this early date, that by this method the virtual aperture of a telescope may be immensely increased by supplementing it by a pair of receiving mirrors beyond the object-glass, catching the light at 45°, and sending it towards the object-glass, where it is caught by two other mirrors, and sent down towards the eye. The interference-fringes now formed will be as if the two slits were separated by the whole distance of the outer mirrors apart. He then says that, by means of a right-and-left-hand screw, the mirrors are to be separated until the fringes disappear; when the angular diameter of the planet, if its disc is circular and uniformly illuminated, will be the ratio of a wave-length of light to the distance between the mirrors, multiplied by the numerical factor 1·22. This factor, it is interesting to note, was obtained by Sir G. B. Airy so long ago as 1834 (*Camb. Phil. Trans.*) as the appropriate number for a uniformly illuminated disc, when he was considering the resolving power of a telescope as dependent on the diameter of its object-glass. (See also Rayleigh, vol. i. p. 416.)

Michelson then goes on:

> "The chief object of the method proposed is the measurement of the apparent size of minute telescopic objects, such as planetoids, satellites, and possibly star discs, and also double stars too close to be resolved in the most powerful telescope . . . It would appear that a one-inch glass may be made to do the work now required of a ten-inch."

In view of the extraordinary and sensational interest which has been aroused by the recent application of this method by Michelson himself, with the aid of collaborators at Mount Wilson Observatory, Pasadena, California, and with the hundred-inch telescope established there, it may be interesting to quote here part of the conclusion of this paper of Michelson's of date 1890:

> "(1) Interference phenomena produced under appropriate conditions from light emanating from a source of finite magnitude become indistinct as the size increases, finally vanishing when the angle subtended by the source is equal to the smallest angle which an equivalent telescope can resolve, multiplied by a constant factor depending on the shape and distribution of light in the source and on the order of the disappearance.
>
> "(2) The vanishing of the fringes can ordinarily be determined with such accuracy that single readings give results from fifty to one hundred times as accurate as can be obtained with a telescope of equal aperture."

Then, after a few more clauses, comes this remarkable anticipation:

> "If among the nearer fixed stars there is any as large as our sun, it would subtend an angle of about one hundredth of a second of arc; and the corresponding distance required to observe this small angle is ten metres, a distance which, while utterly out of question as regards the diameter of a telescope-objective, is still perfectly feasible with a refractometer. There is, however, no inherent improbability of stars presenting a much larger angle than this; and the possibility of gaining some positive knowledge of the real size of these distant luminaries would more than repay the time, care, and patience which it would be necessary to bestow on such a work."

There seemed little hope at that time, and certainly no reasoned expectation, that any stars, except perhaps some of the very nearest, could have discs big enough for perception and measurement even by this virtual telescope of thirty feet aperture. But in the course of the quarter of the present century through which we have lived, mathematical astronomers have been busy. When the history of recent stellar astronomy comes to be written, some living names such as H. N Russell, Shapley, Eddington, and Jeans will shine as stars of the first magnitude. The possibility of giant stars—so named by Hertzsprung—has come above our mental horizon; and Eddington made the notable prediction that a star like Betelgeuse must be in a highly rarefied state at a tremendously high temperature, and that it would be swollen out by the pressure of light to a size almost comparable with the dimensions of a solar system, although it could not contain very much more matter than, say, two or five times our sun. His argument, in brief, is that the spectrum of a young red star like Betelgeuse shows that it cannot be radiating furiously. Why then is it so conspicuous an object to our vision? It can only be because it is of enormous size, its density perhaps a thousand times less than atmospheric air. By utilisation of the data available in the light of his theory of stellar constitution, Eddington made an estimate of the diameter of the star.

So with great skill Michelson and his collaborators got the interferometer to work. After many preliminary adjustments, on December 13, 1920, Dr. F. G. Pease at Mount Wilson, with Michelson's apparatus, measured the diameter of a star for the first time, using Betelgeuse for the purpose. The interference-fringes formed by the star were observed, the object mirrors were gradually separated, and it must have been a joyful moment when, as they grew farther and farther and farther apart, the fringes at the eye end became less distinct and ultimately disappeared. The distance apart of the mirrors now, multiplied by the proper fraction, gave the angular dimensions of the star—a thing which had never before been observed in the history of the world. An estimate of the star's distance gave its actual diameter, and confirmed Eddington's prediction!

Other stars have since been measured, and the giant stars well deserve their name. Moreover, an instrument has been put in the hands of posterity to the power of which we can scarcely set a limit in investigating utterly invisible details, both about the heavenly bodies and about atoms, by the new and powerful method of analysing the radiation which they emit.

The form of instrument adapted to the heavens is, however, not applicable to the atoms The spectrum of atomic radiation is formed by a grating; and Rayleigh showed (see "Collected Papers," page 427, vol. i) that the power of a prism spectroscope is expressed approximately by the number of centimetres of available thickness of glass, which is one form of saying that, to get high definition or separating power, we must use interference depending on a great number of wave-lengths retardation. The resolving power of a grating depends on its total aperture, which must always be limited to inches, since accuracy of ruling over the whole breadth is essential; but one can have retardation gratings, where the interference is caused, not merely by extra distance due to angular slope of path, but by the retarding effect of a dense substance, such as gelatine or something transparent, instead of by the successive obliterations or dark spaces of the grating. There would seem to be no particular advantage in that; but Michelson perceived that the retardation principle might be employed so as to make a grating which combined with its own effect the resolving power of a prism. A slab of glass a centimetre or more thick might be used to give the necessary lag in phase of many thousand wave-lengths, and thereby secure a definition and resolving power unthought of before.

So Michelson designed the Echelon spectroscope, consisting of thick slabs of glass, each protruding a millimetre or so beyond the other—a staircase spectroscope When he brought this out in 1898 in the *Astrophysical Journal*, vol. 8, p. 37 (see also *Am. J. Sci.* and *Camb. Phil. Trans.* for 1898–99), it seemed as if such an instrument could scarcely be constructed, or, if it were constructed, that the number of slabs must be very few. But I understand that the skill of Messrs. Adam Hilger has sufficed to construct an Echelon with so many as fifty slabs; and this, or some similar Echelon, is now a regular instrument in the examination of the minute structure of spectrum lines. Naturally it cannot cover a great range of the spectrum; it has to be fed with light of a nearly definite refrangibility, and then it analyses the light, as a high-power microscope analyses a small range of visible structure.

The striking thing about all these instruments is that they give us, by inference, information about the invisible; and further developments are to be expected. For example, in connexion with stellar variation Prof. Shapley had proposed a theory of periodic pulsation, which would enable a single star to vary without an eclipsing companion; and this hypothesis was taken up by Eddington for the case of the Cepheid variables.

Subsequent repetition of the Mount Wilson interferometer-measurements on Betelgeuse, after an interval, seems to show that variations in diameter actually occur; and probably by this time much more information has been obtained than can here be summarised. But it illustrates the power of the instrument to confirm the indications of theory.

Before leaving this part of the subject it may be interesting to refer physicists to Paper 199 in vol. iv. of Rayleigh's "Collected Papers," also in *Phil. Mag.* for November 1892, in the form of a letter from Lord Rayleigh to Prof. Michelson about the interference bands of nearly homogeneous light.

I will only add further that Michelson has applied his instrument to examination of the Zeeman phenomenon, with inferences about the multiple character of many of the lines, as recorded in his paper on "Radiation in a Magnetic Field" (*Phil. Mag.* for July 1897 and April 1898).

References to Michelson's earlier papers on this subject are:

A general theory of interference-fringes in a refractometer, in *Phil. Mag.* for April 1882; a mathematical paper on the visibility of interference-fringes in the focus of a telescope, in *Phil. Mag.* for March 1891; on the application of interference methods to spectroscopic measurement, in *Phil. Mag.* for September 1892.

Now I find that I have omitted all reference to what is the popularly best-known work of Michelson, the application of his interferometer to determine if possible the motion of the earth through the ether. The speed expected was of the order one-ten-thousandth of the velocity of light; but since the journey of the light in the instrument is a to-and-fro journey—one half-beam going as nearly as possible with and against the hypothetical stream of ether, while the other half-beam goes at right angles to that direction—the amount to be measured was not one-ten-thousandth but the square of that quantity; that is to say, the observer had to measure one part in a hundred million—no easy matter. The apparatus has been so often described, and the theory so often given, that there is no need to say much about it. The interferometer was mounted on a stone slab floating in mercury, and the whole observation conducted with great care. The result was zero; and that zero was used afterwards as the corner-stone of the great and beautiful edifice of relativity.

That so extensive a structure should have been initiated by a zero result is philosophically curious, and shows great faith in the trustworthiness of the experimenters, Michelson and Morley. I am told that Morley, before he died, was rather overawed by the consequences deduced from that experiment, and was anxious that it should be repeated with still greater care, and under many conditions, some of which were indicated in their early paper (*Phil. Mag.*, December 1887), entitled "On the Relative Motion of the Earth and the Luminiferous Æther," by Albert A. Michelson and Edward W. Morley. For even then they suggested, on page 459, that perhaps at moderate distances above the level of the sea, or at the top of an isolated mountain peak, the relative motion might be perceptible.

Such repetition has, as we know, lately been attempted, with results which at present seem too unlikely to be credited; but as Prof. Miller's experiments are *sub judice*, I will say no more about them. I know that Michelson agrees with me (or did in 1920) that there was nothing in the original Michelson-Morley zero result to justify a denial of the existence of the ether; nor is a positive result necessary to re-establish it. The theory of relativity (so called) has led to a search for *absolute* conditions, independent of accidents of motion, the same for all observers; and this search for the absolute will continue, being justified by its brilliant success, quite apart from the corner-stone which is still part of the structure. On the whole, the theory rather tends to strengthen our philosophic conviction of the ether as an integral and absolute ingredient in the universe, although, for purposes of calculation and attainment of results, it—like many other things—can be safely ignored.

I append references to such papers as were published in the *Phil. Mag.* on other subjects, for the convenience of any who would like to look at them:

"Note on an Air-Thermometer" (September 1882); "A Method for Determining the Rate of Tuning-Forks" (February 1883); "On the Relative Motion of the Earth and the Luminiferous Æther"—the first Michelson and Morley paper (December 1887); "On a Method of making the Wave-length of Sodium Light the Actual and Practical Standard of Length" (December 1887); "A New Harmonic Analyser"—Michelson and S. W. Stratton (January 1898); "The Velocity of Light" (March 1902); "The Relative Motion of Earth and Æther" (December 1904); a short mathematical paper on "Diffraction" (April 1905); "On Metallic Colouring in Birds and Insects" (April 1911).

OLIVER LODGE.

Discovery and Dialectics.

Science and Scientists in the Nineteenth Century. By the Rev. Robert H. Murray. Pp. xvii + 450. (London: The Sheldon Press; New York and Toronto: The Macmillan Co., 1925.) 12*s.* 6*d.* net.

DR. MURRAY, who is rector of Broughton and is distinguished as a historical writer, says: "In a sense my book forms an assault upon science, or to put it more correctly, upon the preconceptions that lie at its base far more than most F.R.S.s are aware." It is therefore permissible that a review of it in this journal should be, in a sense, a reply; for the book is very well written, it is interesting to read, and its data are culled from a wide range of the annals of men of science themselves; hence what one must call its misconceptions are likely to impress themselves upon a fairly wide public. On the other hand, there is a great deal in it from which scientific readers cannot fail to draw a very salutary lesson.

The virtue of the book lies in the emphatic warning, well hammered home by numberless examples, against pooh-poohing new ideas. The treatments of Jenner, J. Y. Simpson, Lyell, Joule, Darwin, Pasteur, and Lister by their contemporaries, together with less familiar and more briefly handled cases, are adduced in evidence of the futility of—may one coin a word?—Pooh-poomposity and the shut mind. It is a most valuable sermon on personal faults. Dr. Murray deplores the spending of time and energy which is exacted from discoverers by their need to silence hostile criticism, criticism which has turned out to be incorrect in the end, and has sometimes been rancorously expressed. No one defends personal rancour, whether it is *pro* or *contra*; "a man may be a champion for truth without being an enemy to civility"; and the same holds concerning cocksure affirmations and denials out-of-hand Whilst a lay listener often mistakes philosophic emphasis for personal antagonism when it is nothing of the kind, it remains perfectly true that there are little minds and ignoble minds among men of science as everywhere else, and there always will be. Moreover, no man of science, not even the greatest, has more than a short period in his life during which he is so free from human vanities that his discoveries are faultless and his opinions just.

To Dr. Murray, as a student and a curator of human nature, it has evidently been a disappointment to find, from his reading, that these things are so; but he has allowed them so to prey upon his mind, that he draws conclusions about science itself which are much too cheerless. For Dr. Murray, an admirer of great investigators, makes far too little of the real part which doubt plays in science. Even a great investigator is liable to be affected by the Idols of the Tribe and of the Cave, and when his admirers cavil at adverse conservatism, they are guilty of a worse heresy than are those whom they blame. Although the author does not omit to make mention of this, the tenor of the whole book is undoubtedly to cause it to be ignored by the reader. Scepticism is the great promoter of intellectual progress; and if every plausible idea had received general approval at its birth, or even general tolerance, the effect would have been chaotic—as, indeed, is indicated by the passage from Thucydides which Dr. Murray rather inconsistently quotes as the text of his book. No discovery is actual until it has been widely put to the test, for no discoverer ever sees all round his problem; and the result—one had almost said, the purpose—of opposition is to provoke the originator to make his claim good and better, by more observation. The onus of proof is on the discoverer: he is held guilty of misstatement unless he can clearly show the contrary; and in this ruthless but reverent safeguarding of truth lies the strength of the scientific method, not (as our author appears to think) its shame. Dr. Murray actually makes it a complaint that the man of science is "a dour deevil to convince"; of course he is, and if he had not been, there would have been no science; and the whole dour generation of them must be convinced before the new thing can become the true thing.

There are several matters wherein the author's vivacious biographical accounts might easily lead to a wrong impression. Jenner's opponents were mostly medical practitioners, not men of science; also, though Jenner was proved right about vaccination in the end, he had given a handle to critics, at the time when he had only a *prima facie* case, by having made rash inferences in other fields of study. Again, J. Y. Simpson's opponents were not men of science, they were surgeons; and they contested anæsthesia on ethical rather than on logical grounds, for while he urged that pain is wrong, they thought it natural and salutary. Not dissimilar remarks apply to Lister and antisepsis. As to Lyell in geology, Dr. Murray himself admits that "it was part of the good fortune of Sir Charles Lyell that he had suffered much from opposition." Concerning a problem studied by Darwin which had, unknown to him, been investigated before, is it ever true that a scientific research has been "done once for all"? On Joule and the conservation of energy, to say that Kelvin was "blinded by preconceived notions" is surely a little disrespectful to the vast knowledge of massed facts which is dismissed as "preconceived notions"? Was one research, by one man, to be allowed to change the face of all that Kelvin then knew? More experiments were what he asked for.

The important point that is missed by Dr. Murray, in common with most laymen, is that a research or an idea which can be achieved by one man alone has no standing as a truth in science. We are not as trustful of our own powers as that. When enough people have arrived at the same point, when the new thing has become a statistical experience and no longer an individual experience, then only is it authentic. This is an integral part, it would seem, of the canons of modern scientific proof. The process is like cupellation: the button of rich metal is purged of its dross in the fire of scepticism, and the golden bead of truth remains. Looking back, we see that a proved scientific truth is, in fact, something rather less than the greatest common factor of the current scientific beliefs on the question; it is to be found midway between those who believe too quickly and those who believe too slowly; and inevitably in due time it prevails, and it begets fresh truths. The business is certainly cumbrous and almost painfully slow—especially to those who cannot take part in it—because so many of us, being human, are as stupid as any of our lay brothers. But the process seems nevertheless to "get there" far more rapidly and more surely than does any other mode of inquiry.

Dr. Murray uncovers without concealment the axe which he has to grind. "One main purpose," he says, "in writing this book has been to prove that there are just as many preconceived notions in science as there are in theology"; and later he adds that his book stands or falls largely by this thesis He gives us, however, only one side of his equation, for we are not given the corresponding washing of the theologians' linen; and it strikes the unsophisticated scientific reader as a very cynical and despairing warrant for his line of argument when the author says: "In logic two blacks do not make a white, but in life they sometimes do." Apart from these merely dialectic comments, there remains one cardinal error, which vitiates the whole thesis: namely, to decry what lies at the base of science simply because its students are apt to go outside the scientific method. One might as well argue: "Some plumbers are socialists; I do not believe in Socialism, therefore a system of sanitation must be a bad thing." Science is the discovery of things, not a society of persons

The layman who reads this book would probably be led to fall into the same pit as its author, confusing investigators with what they help to discover; and the book is thus a poor guide for him. To scientific readers it forms a powerful sermon on good manners; it is a large collection of interesting personalia; and it can be recommended accordingly. IRVINE MASSON.

Popular Science.

(1) *Electricity and the Structure of Matter.* By L. Southerns. (The World's Manuals.) Pp. 128. (London: Oxford University Press, 1925.) 2s. 6d. net.

(2) *The Story of Electricity from Thales to Einstein.* By W. F. F. Shearcroft. (Stories of Science Series.) Pp. 73. (London: Ernest Benn, Ltd., 1925.) 2s. 6d.; stiff cloth, 3s. 6d.

(3) *Readable School Electricity.* By Vivian T. Saunders. (Bell's Natural Science Series.) Pp. xii + 176 + 8 plates. (London: G. Bell and Sons, Ltd., 1925.) 2s. 6d.

(4) *The Electron: its Isolation and Measurement and the Determination of some of its Properties.* By Prof. Robert Andrews Millikan. (University of Chicago Science Series.) Second edition, second impression. Pp. xiv + 293. (Chicago: University of Chicago Press; London: Cambridge University Press, 1924.) 9s. 6d.

(5) *Die Evolution des Geistes der Physik 1873–1923.* Von Prof. A. D. Chwolson. Aus dem Russischen übersetzt von Prof. V. R. Bursian. Pp. vi + 197. (Braunschweig: Friedr. Vieweg und Sohn, A.-G., 1925.) 10 gold marks.

IF the output of the publishing press is a valid criterion, there is as yet no abatement of the wave of popular interest in physical and, in particular, in electrical science. Electricity is very much in the air at present. Schemes of electrification on a gigantic scale are advocated in Parliament and in the press. Above all, "wireless" receivers with their inductances and capacities, their metres and wave-lengths, and their valves, which brightly or dully glowing make the set not infrequently more pleasant to watch than to listen to, have brought the mysteries of electrical science on to the domestic hearth. It is not surprising that there are a considerable number of people who would like to know, if it can be managed without too much mental labour on their part, what electricity is and how it works. That such a demand really exists is proved by the statement of one of the authors of the volumes enumerated above, that he has been induced to produce the present volume by the hearty welcome to a former book on similar lines.

The demand is not an easy one to satisfy. The book must be cheap (there seems to be some unanimity among publishers that its price should be 2s. 6d.), for the desire to know is not one of those imperious passions which must be satisfied at any price. It must not require much from the reader in the way of concentration, or active thought. It must be attractively written and well illustrated, with photographs rather than diagrams, for diagrams are cold and repellent to all except the real enthusiast. In addition, the author will, in order to satisfy his own conscience, wish the book to convey some genuine knowledge to the reader, and to produce in his mind impressions which are not too unlike the actual facts. It is, of course, this last self-imposed condition which makes the writing of these books so difficult.

(1) Of the first three books on the list above, we think that "Electricity and the Structure of Matter" by Mr. Southerns is the most successful. Mr. Southerns has selected his material well, and shows, in his treatment of it, a light and deft touch. He possesses a fine sense of showmanship, which in the illustration where the author's pen pauses a moment to be X-rayed, rises almost to genius. He will probably find, however, that the X-ray installation figured in the frontispiece will work more satisfactorily if he connects in the condenser The book is most attractively illustrated and produced, and can be recommended warmly to any reader in search of a pleasant and not too profound account of modern electrical science.

(2) In comparison "The Story of Electricity" by W. F. F. Shearcroft is dull, and in spite of its dullness is distinctly less informative than the preceding volume. To attempt to deal with relativity in five small pages, and with the quantum theory in three, is asking for trouble. With the author's obvious desire to illustrate the nature and methods of scientific progress by a history of one of the sciences we have every sympathy. An excellent book might be written on these lines. It is not, however, a thesis which can be adequately developed in 62 pages of text.

(3) "Readable School Electricity" stands on a somewhat different footing from the two volumes already noticed, as it proclaims itself as being specifically a school book, one of the newer type based on the thesis that the object of a school book should be to stimulate the interest of the beginner, in the hope that, when his interest is stimulated, he will himself demand to be taught the grammar of the subject, so necessary to any true knowledge, but at the same time inevitably so dull. This is a thesis on which school masters and university teachers are apt to hold divergent views. The author of the present volume is not an extreme supporter of the thesis, and though the book deals mainly with applications of electricity, it is by no means entirely superficial, and there are scholarly touches which are most welcome in a school book on science.

(4) and (5) If any justification is possible for including in one and the same notice the volumes we have just dealt with and the two that remain for review, it must be that whereas the former represent a fair average of what popular science is, and perhaps must be at the present time, the latter are bright and shining examples of what it may become when a true interest in science for its own sake, and a real appreciation of its aims and discoveries, have become more general than they are as yet. The fact that Dr. Millikan's classic "The Electron," after running through nine impressions in eight years, has now reached a second edition, of which the copy for review is part of a second impression, would, however, seem to give grounds for hope that this educated public is not even now so small as we might, in atrabiliar moments, be inclined to believe; and will, we hope, encourage authors and publishers to give us more books of the same stamp. To praise such a book as "The Electron" is superfluous. Dr. Millikan is well known to be as skilful with his pen as in his laboratory. We need only add that the new edition contains fresh matter which brings his account of his subject well up-to-date, and readers of the first edition will certainly wish to see it.

Prof. Chwolson's scholarly volume "Die Evolution des Geistes der Physik 1873–1923" raises questions far too complex to be dealt with at the tail end of an omnibus review. He has been a close and not unfriendly observer and critic of the progress of physics throughout the period with which he deals. He believes that the last fifty years have seen not merely a growth in the content, but also a change in the spirit of the subject, which it is the object of his book to demonstrate The book is thus more than a résumé—it is a criticism, and to a science suffering somewhat from a surfeit of its own discoveries, and inclined a little, perhaps, towards swelled-headedness, a friendly dose of cold water may be not merely salutary but even welcome. Many students who have profited from Prof. Chwolson's monumental text-book will at least be glad to have his matured opinion of what they have done with their instruction. We should welcome an English edition of this thoughtful little book. Should some kindly publisher be willing to increase our indebtedness to himself by placing an English version on his list, we hope he will not be misled by the title of this article into classifying it as popular science.

Physico-Chemical Problems of the Cell.

La cinétique du développement : multiplication cellulaire et croissance. Par Dr. E. Fauré-Fremiet. (Les problèmes biologiques.) Pp. viii+336. (Paris: Les Presses universitaires de France, 1925.) 35 francs.

AS its title indicates, this book deals with the problems of development from the point of view of changes in the energy potential and the physico-chemical constitution of the animal organism A very wide field is covered embracing the experimental aspects of embryology and cytology, and the very numerous and various facts presented are, by the method of treatment, welded into one consistent whole. Apart from its originality of outlook, the book is undoubtedly of great value to all experimental biologists merely as a work of reference. The author's solution of the problem of what to omit will probably, in the main, meet with approval. It is at first sight strange to dismiss in a short footnote (p. 114) the evidence for the permanency of the chromosomes, but as information on this point is readily available in numerous text-books, the author has perhaps chosen wisely in omitting it here. The omission of any discussion on regeneration, with the exception of a short account of the healing of wounds, is more to be regretted. The problems of regeneration and those of development are undoubtedly closely allied, and the scattered facts and theories of regeneration could well bear such a critical review as the author has, in this book, bestowed upon other problems

The first three chapters deal, broadly speaking, with the physico-chemical constitution of the cell, and the changes therein, during growth and division, and to a large extent may be said to be based on Zwaardemaker's conception of the application of the phase rule to the problem of protoplasmic structure. The author admits frankly that in the present state of our knowledge the application of this rule can be only tentative. This conception has been used with admirable discretion, and perhaps its main virtue is that it has enabled the author to link together in one connected and extremely interesting whole the very considerable number of facts and theories here presented. Perhaps too much mystery is made of the nucleus-cytoplasm volume relationship; the discussion of this would have been greatly simplified by beginning from the obvious consideration that materials for nuclear growth can only reach the nucleus by first passing through the cytoplasm. Indeed, it may be regarded as certain that the raw food materials of the cell are not available for use by the nucleus until they have been very considerably altered by the cytoplasm. Obviously, then, after division of a cell there must be a lag in the rate of growth of the nucleus of the daughter cell as compared with its cytoplasm, since, except for the possible persistence of small quantities of nuclear "food" in the cytoplasm of the daughter cell, the nucleus has to wait for its supplies of food material until these are elaborated by the cytoplasm. Many, though not all, of the various changes in the nucleus-cytoplasm volume relationship are explicable in this simple manner. A minor point of criticism in this chapter is that the table given on p. 90 is by no means clear until reference is made to the footnote on p. 92. As it stands, the table will be taken to show the number of cells developing from a fertilised Strongylocentrotus egg in a given time at various temperatures, and proves little beyond the obvious fact that at low temperatures development is less rapid. The comparison intended is between larvæ of the same degree of morphological evolution reared at various temperatures, and shows that at low temperatures the larvæ contain fewer cells and relatively larger nuclei than larvæ of an equal degree of morphological differentiation reared at higher temperatures.

Chapter 4 deals with the very difficult subject of energy transformations during embryonic development. This chapter suffers somewhat from a plethora of cold facts, and is apt to leave the non-specialist with no very clear ideas on the subject. The blame for this may perhaps with more justice be laid on the subject than on the author, as the study of the energetics of development has as yet scarcely emerged from the chaos and multiplicity of disconnected facts which is the necessary but unpleasant beginning of most sciences. The remaining three chapters deal respectively with growth in metazoa, multiplication of Protozoa, and growth in tissue cultures. The chapter on Protozoa is, of three good chapters, the best, and provides a most excellent summary of its subject. In the chapter on tissue culture, the author is to be congratulated on having included such things as the healing of wounds and the growth of grafts, and on having shown the relationship of these phenomena with those of tissue culture *sensu stricto*.

The mathematical treatment adopted in many places throughout the book will be regarded by the non-mathematical biologist as a painful necessity, and to such may give some little difficulty. In some of the tables of figures the author has omitted to state the units to which his figures refer. Though reference to the context usually clears up this point with little difficulty, the omission is none the less annoying. But whatever minor faults this volume may contain, it is not only a fine work of reference, but also has in an eminent degree the still higher excellence of originating fresh ideas, suggesting new experiments, and fortifying that modern conception of biological inquiry the adherents of which are striving little by little, with progress however slow and doubtful, towards the ultimate goal of raising biology to the rank of an exact science; of explaining "vital" processes in terms of physical and chemical units.

J. G. H. F.

The American Coal Commission.

What the Coal Commission Found: an Authoritative Digest and Summary of the Facts about Coal. By Staff Members. Edited by Edward Eyre Hunt, F. G Tryon, and Joseph H. Willits. (Human Relations Series.) Pp. 416. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1925.) 25*s*. net.

THE need for a careful study of the many difficult problems presented by the coal industry led to the appointment towards the end of 1922 of the United States Coal Commission, which continued to function for eleven months, during which time it spent about 120,000*l*. and employed at one time more than 500 persons. The very voluminous records and findings of the Commission have been conveniently condensed in the present volume of a little more than 400 pages, in which are collected together the important portions in an eminently readable form. Its appearance at the present moment is particularly important in view of the fact that we, too, have a Coal Commission now sitting for the purpose of studying the same industry in Great Britain, and the findings of the American Commission will assuredly afford some useful guidance, though it is obvious that the problems in the two countries are in many respects widely different.

In the United States the essential problem is how to ensure an uninterrupted supply of coal to the industries and the people generally; in Great Britain the problem is how to bring down the cost of production of coal to such a level as to enable British collieries to compete successfully in the world's markets America is to some extent indifferent to the cost of production, because America is a self-contained country, producing within its own borders everything that is needed for the nation's well-being. In Great Britain, on the other hand, the cost of production is the dominating factor, because it is only by means of coal produced sufficiently cheaply to enable it and the various articles, for the manufacture of which it is indispensable, to be sold at competitive prices in the markets of the world.

In spite of this wide divergence in the character of the problems, it becomes evident upon investigation that the underlying causes which have given rise to them are very similar. The findings of the American Coal Commission are therefore not without their value for British investigators. It must, however, be pointed out that the American Commission has been careful to distinguish between bituminous coal and anthracite, and that it is only the former portion of the subject that finds any counterpart in Great Britain. Perhaps the most interesting sentence in the book is the record of the finding of the Commission that there is "no reason to believe that a dependable supply of coal at a reasonable price is inconsistent with reasonable conditions of life and citizenship for the miners, or with a reasonable return on judicious investments." In order to attain this most desirable consummation a number of recommendations were made, though it appears to have been fully recognised that, in the words of John Hays Hammond, who contributes a foreword to the volume, "There is no easy panacea for the troubled industry."

The most important recommendations were those addressed to the industry itself, and these include the development and efficient application of mechanical devices to replace hand loading, better control and co-ordination of underground operations, standardisation and co-ordination of the work of the individual mine-worker, standardisation of details of construction and dimensions of all mine equipment. In respect of Government action, the recommendations are mainly negative; thus compulsory arbitration and nationalisation of the mines were not recommended. Curiously enough, the British wage agreement, the termination of which has precipitated our coal crisis, comes in for approval. Finally, the fact is stressed that this is not a question to be fought out between the colliery owners and the coal miners alone, but that the public is vitally interested, and this last statement is even more profoundly true in Great Britain than in the United States. Hence comes the need for the public to receive authentic and unbiassed information on all matters concerning the coal industry, so that "guided by facts rather than rumours, by information rather than prejudice, the people will be able to exercise wisely the powers of the Government over this type of private business."

H. LOUIS.

Our Bookshelf.

(1) *Laboratory Manual in General and Pathogenic Bacteriology and Immunity.* By Prof. Veranus Alva Moore and Prof. William Arthur Hagan. Pp. xii + 252. (Boston, New York and London: Ginn and Co., 1925.) 8*s.* 6*d.* net.

(2) *Bacteriology: a Text Book on Fundamentals.* By Prof. Stanley Thomas. Pp. xiii + 201. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 12*s.* 6*d.* net.

(1) THE first of these books is intended to be a laboratory guide on bacteriology for veterinary students. It consists of practical exercises, and at the end of each exercise is a series of questions. The latter seem uniformly to have little or no bearing on the particular exercise. Thus Exercise No. viii. is headed "Making plate cultures: the Gram stain," but it contains no information about the Gram stain. Nevertheless, the student is asked the question at the end of the exercise, "What is the function of the iodine solution in the Gram technic?" The only answer to this question which we can find in the book is given in Exercise vii., in which it is stated that "little is known of the chemical process involved in the Gram stain." This kind of sample has not been particularly selected. It occurs more or less throughout the book. English examiners would not cordially accept an answer like this from a candidate.

(2) The second book is by Stanley Thomas, who is associate professor of bacteriology in Lehigh University, Bethlehem, Pa. It is a general account of bacteria and their actions. It is well written, covers a good deal of ground, and is for the most part accurate. The author's statements on the history of bacteriology require correction, and his chapters on pathogenic bacteria indicate that he is not so much at home with them as when he deals with bacteriology applied to public health.

The Strength of Materials: a Treatise on the Theory of Stress Calculations, for Engineers. By John Case. Pp. viii + 558. (London: Edward Arnold and Co., 1925.) 30*s.* net.

THE book under notice differs somewhat in its purpose from the usual text-books on the subject, in that little space is given to discussion of the physical properties of materials or to experimental work. On this account the author's sub-title, "The Theory of Stress Calculations," is perhaps more appropriate, expressing more correctly the scope of the work. The sequence adopted for the various branches of the subject is open to criticism, but the theoretical treatments covering a wide range of problems of real importance to the engineer are very complete, except in some of the more advanced portions of the work, as for example in the account given of the torsion of non-circular shafts, where the results of the theory are stated only.

In the later portion of the book a treatment is given of the temperature stresses in thick cylinders, and in view of its importance, the more general problem of the stresses in cylinders and discs due to any concentric temperature distribution, on the lines of Prof. C. H. Lees' work, might well have been included as it presents no great difficulties. A good abridged account of Prof.

C. E. Inglis's work on the transverse oscillations of beams is given, but the chapter on the whirling of shafts is scarcely satisfactory, as no account of this subject in a modern treatise can be so considered which omits to take account of the general question of the stability of the motion and the factors which govern it. The whole is none the less a welcome contribution to engineering literature. The numerous references to various authorities contained in the footnotes are not the least valuable feature of the book, and, in addition to sets of good examples at the ends of the chapters, a large variety of interesting and instructive practical examples are worked out in the text. E. H. L.

Air Ministry: Meteorological Office. The Weather Map: an Introduction to Modern Meteorology. By Sir Napier Shaw. (Published by Authority of the Meteorological Committee.) Sixth issue. (M.O. 225i.) Pp. 112 + 8 plates + 8 charts. (London: H.M. Stationery Office, 1925.) 1*s.* 3*d* net.

THIS publication was first issued in 1916 for the benefit primarily of those who were making use of meteorology in the War. The work has naturally grown, although only slight alterations are made in the present issue. A note on visibility has been added. The book is of the highest possible value to those who wish to obtain an intelligent interest in the weather and its numerous and complicated changes. The author, who has done much to place meteorology in its present position among the sciences, has achieved an immense success in placing modern meteorology so thoroughly and so simply before his readers. With the extensive broadcasting of the weather forecasts, many are wishful of obtaining an intelligent insight into the construction of the weather map and the weather changes indicated. The sequence of the weather is dealt with, and simple types are given showing the influence of time on changes of weather, winds, temperature, and pressure. Tables and maps are given for the reduction of the observations and show the average or normal conditions of the several elements for the whole or any part of the British Islands. A chapter is given on the upper air; it is stated that the world's height record in an aeroplane is 39,587 feet, achieved by M Callizo on October 10, 1924, at Villacoublay near Paris. The highest mountain climb was achieved by the climbing party on Mount Everest, seen on June 8, 1924, at a height of 28,230 feet. The ballon-sonde has enabled temperature observations to the height of 22 miles, and on many occasions up to 12 miles.

(1) *The New Matriculation Geometry.* By A. G. Cracknell and G. F. Perrott. Pp. x+303. (London: University Tutorial Press, Ltd., 1925) 4*s* 6*d*.

(2) *A School Geometry on "New Sequence" Lines.* By W. M. Baker and A. A. Bourne. (Cambridge Mathematical Series.) Pp. viii+307. (London: G. Bell and Sons, Ltd., 1925.) Books 1-3, 2*s.* 6*d.*; Books 1-5, 4*s.*

THE teachers who objected to the introduction of a "new sequence" in geometry on the grounds that it would merely mean the exchange of Euclid's yoke for another scarcely less objectionable, have evidently some justification for their fears. Both these books give no less than 120 propositions to cover the substance of Euclid I.-IV., in addition to which the former dismisses similar figures in 10 pages, and the latter deals adequately with the propositions of Euclid VI. and XI. Surely some of these 120 propositions could with advantage be treated as riders or, at any rate, a clear distinction should be made between propositions which the pupil is supposed to reproduce and those he is merely asked to understand.

It is interesting to note that the method of superposition flourishes as if nothing had been said to its detriment during the past twenty years.

The riders in both books are good and numerous, but in "The New Matriculation Geometry" the bulk of them are collected together at the end of the book.

Leitfossilien: ein Hilfsbuch zum Bestimmen von Versteinerungen bei geologischen Arbeiten in der Sammlung und im Felde. Herausgegeben von Georg Gürich. Vierte Lieferung: Leitfossilien der Trias Wirbellose Tiere und Kalkalgen, von C. Diener. Pp. ii+118+28 Tafeln (Berlin: Gebrüder Borntraeger, 1925.) 24 gold marks.

THE publication of this useful work on characteristic fossils has extended over a long period. Part 1 (Cambrian and Silurian) was issued in 1908; part 2 (Devonian) in 1909; part 3 (Carboniferous and Permian) in 1923. The portion recently published deals with the invertebrates and calcareous algæ of the marine Trias, and has the inestimable advantages of being the work of Prof. C. Diener, whose researches on Triassic cephalopods are known to all geologists and palæontologists. The treatment of the subject is strictly systematic; in each group of fossils the characters of the families and genera are given, with notes on some of the important species. The work is illustrated by numerous figures, mainly copied from the memoirs of recognised authorities, but those of the calcareous algæ are from original drawings by Dr Julius Pia. Short but useful bibliographies are given for each group of fossils. The work concludes with tables showing the stratigraphical divisions, and the ranges of the characteristic fossils, in all the principal regions of the world where the marine Trias is developed It is to be regretted that this part, like parts 1 and 2, is without an index.

The Mathematical Theory of Electricity and Magnetism. By Dr. J. H. Jeans. Fifth edition. Pp. viii+652. (Cambridge: At the University Press, 1925.) 21*s.* net.

THE fifth edition of an established text-book calls for little comment. The previous edition was marked by the introduction of a new chapter on the theory of relativity. The present volume has yet another new chapter on "The Electrical Structure of Matter," intended as an introduction to the quantum theory. It seems rather sad that this new chapter should have to confess that some of the conclusions in the earlier part of the book—as to the radiation of energy from an accelerated electron—are in contradiction with modern knowledge, and that the whole theory which led to those conclusions is in need of amendment, but such is the history of science The chapter will admirably serve its purpose of leading up to modern theory.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Transmutation of Elements.

A Transmutation of Lead (First Method).

SINCE the publication of my letter in NATURE of October 25, 1924, on the transformation of elements, I have continued the experiments in collaboration with Dr. A. Karssen.

The quartz lead-lamp, after being altered several times, was finally given the following definite construction (Fig. 1). The two legs are bent upwards, and the lower ends of one of the steel electrodes, one of which is provided with a piece of carbon, are ground to a tight joint into the legs, so that they can serve as cocks. The electrodes are connected with the legs of the lamp in a completely air-tight manner without the use of mercury. This lamp, containing, of course, also a storage vessel, is mounted on a stand provided with a wide copper tube with a series of gas burners to keep the lead in the lamp in a molten condition.

Further, the lamp is provided with two other copper tubes connected with a conduit pipe from the compressed air supply to cool those parts of the lamp which are heated too highly by the electric arc.

In our experiments we had to consider the possibility of the transformation of lead into mercury, which makes it desirable, of course, to avoid the use of a mercury air-pump and a mercury manometer. Therefore, the lamp initially was evacuated by a carefully cleaned metallic pump, connected with two U-tubes, placed in liquid air, and finally with a large vessel filled with coconut charcoal, also cooled in liquid air, by which method a high vacuum could be obtained. If not working in vacuum the pressure was measured by a glass spring manometer provided with a calibrated scale. Working under pressure, the connexion with the coconut charcoal vessel was broken, and pure nitrogen was admitted.

It is evident that in researches such as are mentioned here, the material used must be as pure as possible. The firm of Kahlbaum was so kind as to prepare for us an extra pure preparation of lead with the utmost care to prevent every contamination, especially by mercury vapour. In this preparation neither mercury nor thallium could be detected analytically.

The quartz parts of the lead lamp were cleaned by a solution of potassium dichromate and nitric acid, then steamed, and then finally heated to redness in a current of dried air. The metallic parts of the lamp, made of steel, after cleaning were heated to redness and the carbon valve underwent exactly the same treatment. *All these materials, examined spectroscopically, were shown to be completely free from mercury and thallium.*

The method of investigation used by us was as follows: After filling the storage vessel, the lamp and the lead were heated in high vacuum to redness. The lead oxide being dissociated, the liquid lead was as brilliant as mercury. Then the lead was brought into the lamp, and after ignition the spectrum was observed at 25 volt and 36 amp, by a Hilger quartz-spectrograph. Further, the spectrum of a quartz mercury lamp was observed, and also the scale in such a way that, to facilitate comparison, the different spectra were adjacent. Thus we obtained the spectrum of the lead in its initial state. After that we burned the lamp at 40 amp. and ± 80 volt for 10 hours. After having done this the lead was poured into the storage vessel to obtain thorough mixing; the lead was then brought into the lamp again, and after ignition the spectrum was observed at 25 volt and 36 amp. The result was that, whilst initially the lead spectrum showed only very weakly the mercury line 2536 in the ultra-violet, after 10 hours' burning the strongest mercury lines had appeared in the visible as well as in the ultra-violet part of the spectrum, and also the most characteristic thallium line, indicating a transmutation of lead into mercury and thallium.

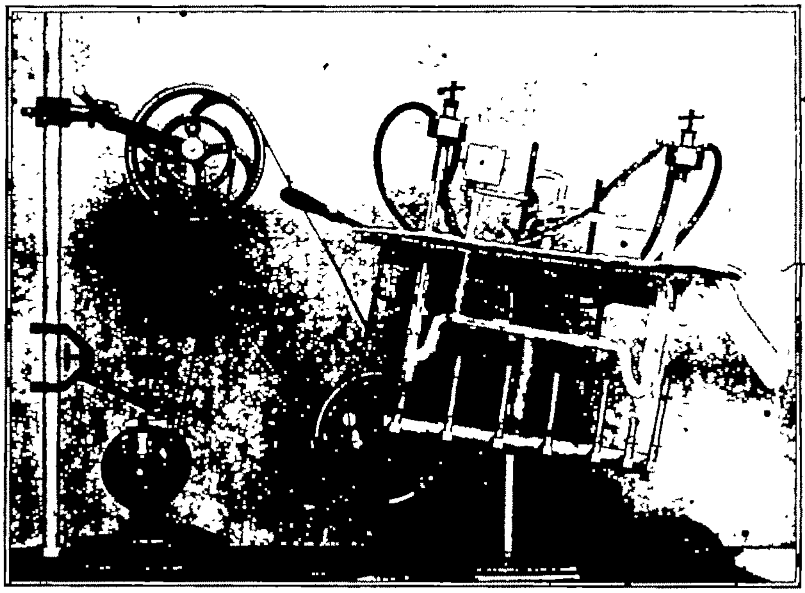

FIG. 1.—Quartz lead-lamp.

Since our experiments showed that a high current density is very favourable to this transformation, we used currents up to 60 amp., but that seemed to be dangerous, because only by intensive air cooling could melting of the quartz-lamp be prevented.

We thought it better, therefore, to change our method a little, by applying not a continuous electrical current but sparks of high current densities. Therefore, the lead lamp and the delivery tube with gas burners, and the cables and cooling tubes, were all mounted on the same stand, turning on a horizontal axle. While the lamp was kept oscillating by a mechanical arrangement as shown in Fig. 1, a current of high density was breaking and making. At make the current was 60–100 amp., and since the last contact is made by a very thin spout of liquid lead, the current density on the moment of breaking the current will be exceedingly high. This method was very successful. Since at the places where sparks are emitted a black film appears, it was necessary before observing the spectrum to clean the quartz tube as well as possible by burning the lamp half an hour continuously. After that the lead was poured into the storage vessel and then again into the lamp, as already mentioned, the spectra obtained now showed a much stronger transmutation, and after 9½ hours' sparking all mercury lines, even the very weak ones, were present.

Our purpose, of course, was to see what the result would be after continuing our experiments a very long time. In this case, however, we met a great difficulty, since the quartz became corroded strongly by the lead, forming a film of lead-silicate, blackened by silicon.

To make us independent of the formation of this film, at the place where the arc in the lamp is formed a quartz tube (observation tube) of 15 cm. length and 8 mm. diameter was sealed, the upper end of which was provided with a flat bottom.

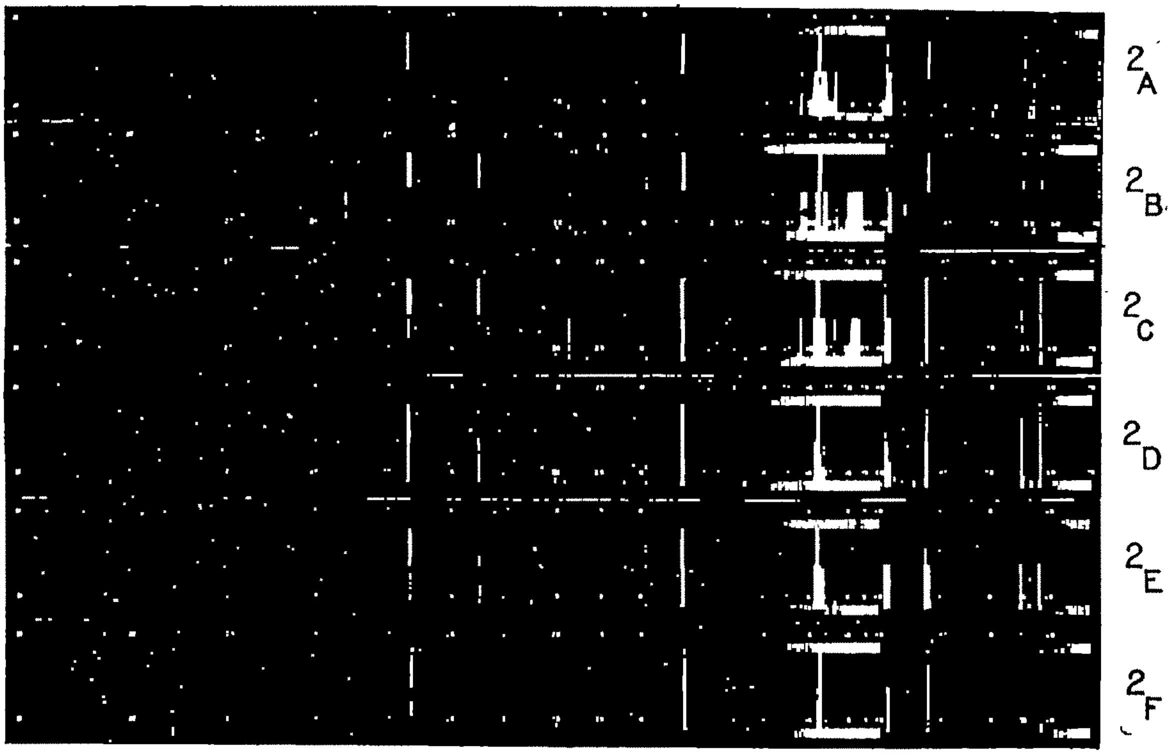

FIG. 2.—Spectra of lead with comparison spectra of mercury, the upper spectrum in each case being that of mercury. (Some of the very faint lines have not appeared in the reproduction.)

The light of the arc passing through the unattacked quartz-bottom, reflected by a nickel mirror, was directed to the quartz-spectrograph. Fig. 1 shows the observation tube and the nickel mirror. By this means the transmutation can be studied so long as the lamp stands.

Fig. 2 shows the results. The mercury spectrum is in each case placed above the lead spectrum. Fig. 2A shows the mercury spectrum at the top, and at the bottom the spectrum of the extra pure lead in the initial state. It is seen that this lead preparation is very pure: the lead spectrum does not contain mercury lines. The negative being always a little more distinct than the prints shows a very weak indication of the mercury line 2536, that is, the line which always appears in our experiments first.

Burning and sparking we obtained successively the photographs reproduced above as Fig. 2. 2B was after burning half an hour at high current density; 2C, after 2½ hour sparking; 2D, after 8½ hour sparking; 2E, after 12 hour sparking; and 2F, after 39 hour sparking.

We see in photograph 2B the green and the indigo mercury line, and some lines in the ultra-violet have already appeared. The line 2536 is strongest. The double yellow mercury line is not yet present. In 2C more mercury lines have appeared, and the lines already present in 2B have become much stronger. The double yellow mercury line has also appeared. In 2D and 2E the mercury lines are distinctly prominent over the lead lines in the lead spectrum. To make the results as convincing as possible the time of exposure in photographing the lead spectra was 20 minutes in the case of 2A and 2B, 15 minutes in the case of 2C and 2D, and 10 minutes in the case of 2E. Finally, in the case of 2F, the exposure was only 3 minutes, and now we see that the lead lines in the visible part of the spectrum have disappeared, and in the ultra-violet the lead lines have weakened. The mercury lines, however, are very distinct along the whole spectrum.

This, however, does not yet prove the transmutation to be strong, as it is known that a relatively small quantity of mercury can cause the spectrum of another element to disappear. But at all events our spectra show in a very convincing way the transmutation of lead into mercury. As to the thallium lines, it is very remarkable that these lines appear only if the spectrum is photographed directly, that is to say, not using the observation tube, but pointing the light emitted by the lamp directly to the quartz-spectrograph. This seems to be connected with the fact that thallium, like lead, is taken up by the quartz. So we state that the formation of a film of lead silicate results in a stronger lead spectrum if observed directly. This phenomenon will be referred to in another place.

A Transmutation of Lead (*Second Method*).

After having shown the transmutation of lead by the method mentioned above, we applied another very successful sparking method. Extra pure lead supplied by Kahlbaum was heated in a quartz tube up to about 800° for an hour, whilst a current of pure nitrogen was bubbled through. We thus obtained a lead preparation comparable with the lead in our lead lamp, in which it was heated to this temperature in a high vacuum. From the lead obtained in this way, two lead electrodes of 14 mm. diameter were made. Between these electrodes, mounted vertically at a distance of about 4 mm. apart in a vessel with a liquid dielectric, sparks at a voltage of 100,000 volt and 2 milliamperes were sent through the liquid for 12 hours.

The dispersed lead was partly at the bottom and partly in colloidal solution. The fine lead at the bottom of the vessel was collected, washed successively in pure benzene, alcohol, and ether, and finally dried in a desiccator. The metal in the colloidal solution was converted into nitrate by treating the liquid with pure nitric acid at 100°.

After evaporating the aqueous solution on a water bath, the nitrate was placed in a desiccator.

Both substances were examined. The method of analysis was substantially a method of Jannash (*Z. fur Anorg Chemie*, 12, 143 (1900)), as modified by us. Mercury eventually present is driven out by heating in a current of air and condensed in a glass capillary. Then iodine vapour is conducted over it, forming with mercury the red modification of the compound HgI_2. This extremely sensitive reaction, if applied to the electrodes as prepared by us from the extra pure Kahlbaum lead, showed that these electrodes were completely free from mercury, but the dispersed lead obtained by sparking in the circumstances mentioned showed a very distinct mercury reaction.

Consequently, also by this second method, the transmutation of lead into mercury could be realised.

Whether thallium is also formed is being examined.

Both methods mentioned above will be applied soon to bismuth, thallium, and other elements to be considered here.

In another letter we propose to give the results of the quantitative analyses and some theoretical considerations.

A. SMITS.

Laboratory of General and Inorganic Chemistry,
University of Amsterdam,
November 29.

Selective Action of Polarised Light upon Starch Grains.

THE letter of Prof. E. C. C. Baly and Dr E. S. Semmens in NATURE of December 5, p. 817, on the selective chemical action of polarised light upon starch grains seems to me to raise a question of fundamental importance for optics. Is it possible to reconcile such an action with received views about the kinematic relations of polarised light?

Let us begin by considering a case where difficulty does *not* arise. Baly and Semmens refer to Padoa's observation that "crystals of *o*-nitrobenzaldehyde are selectively decomposed by polarised light, *provided that the crystals are correctly oriented to the plane of polarisation*" (my italics). I have not had the opportunity of consulting Padoa's paper, and know nothing of the details; but there is no obvious *a priori* reason why such an action should not occur: for the molecules in the crystal are all similarly oriented, and may well be less able to withstand a displacement in one particular direction than in the perpendicular one.

It is easy, however, to pass to a case where the difficulty does arise. Suppose the crystal pulverised, and the fragments shaken up so as to be oriented at random. They cannot now be all favourably oriented to the polarised beam. Some of them, on the other hand, will be more favourably oriented to a beam polarised at right angles to the first; and if both beams were present, they would presumably add their effect. We can get the two beams instead of one by simply *removing the polariser*, or, in other words, using unpolarised light. It seems clear that in this case polarising the light (with inevitable loss of half of the intensity) must *diminish* the chemical action. The same reasoning seems to apply with equal force to the case of the starch grains, assuming that these are oriented at random.

Great caution is required in weighing any *a priori* reasoning against what seems the result of direct observation. Both, however, involve the human element, and both are therefore liable to be wrong.

RAYLEIGH.

Terling Place, Chelmsford,
December 14.

IT was with much interest that I read the letter relating to the action of polarised light on starch hydrolysis contributed to NATURE of December 5 by Prof. Baly and Dr. Semmens. This letter, since the writers refer to a short "note" by myself in the *Annals of Botany* (July 1925), calls for a brief reply.

Prof. Baly and Dr. Semmens are, like myself, under misapprehension. I desired to call in question, not the possibility of the phenomenon occurring, but the trustworthiness of the evidence put forward by these authors in their paper (*Proc. Roy. Soc.*, 97 B, 250, 1924). The fact that a large amount of evidence in favour of the occurrence of this phenomenon may have been published by the authors or others elsewhere appears to me to be of great interest but quite irrelevant in so far as objection is taken to the "note" for which I was responsible. For example, Weigert's observations on the effect of polarised light on the photographic plate do not make me any readier to believe that potato starch grains in weak diastase solution, after four hours' exposure to polarised light, as a result of hydrolysis will present the appearance shown in Fig. 3, Plate 12, in the paper criticised. I am also dreadfully puzzled to understand why this figure, described in the text as showing "hydrolysis obtained with light polarised by a Nicol prism," was published, if it was not intended as evidence. The "complete disappearance of the grains" I have not observed with potato starch even after some days in strong diastase solution: in my experience a kind of "starch shell," which does not give a blue colour with iodine, persists obstinately.

Since an experiment of my own is cited (which was additional to a repetition of any described by the authors) in which a gelatine film was used, I may perhaps point out that the starch grains were resting on the surface of the gelatine, which was used merely as a convenient adhesive surface to prevent the grains from moving about, and that the polarised light reached the grains without passing previously through the gelatine film. But I should regard any such experiments that give a negative result as of little importance compared with one conclusive experiment of which the result was consistently positive: and no doubt Prof. Baly and Dr Semmens will agree with me in this. The position remains unsatisfactory, however, until the reason for the negative result receives satisfactory explanation.

As one who has suffered from the painful effects of traversing in full sun snowfields in the Alps, I was interested to learn that this effect was due to "the well-known influence of polarised light." I do not feel, however, that an argument of the form—"certain effects are produced by light on crossing a snowfield—some of this light is polarised—therefore the effects are due to the polarised light"—will withstand logical analysis.

W. NEILSON JONES.

Bedford College,
Regent's Park, N.W.1.

The Occurrence of Dwi-Manganese (At. No. 75) in Manganese Salts.

As the present writer is responsible for the polarographic investigations of solutions containing dwi-manganese (see letter by Dolejšek and Heyrovský, NATURE, 116, p. 782), he alone replies to the criticism of the above letter by Mr. A. N. Campbell (NATURE, 116, p. 866). This criticism shows a misunderstanding of what the polarographic-electro-analysis with the dropping mercury cathode really means. First of all, the present author's potentials refer, as expressly stated, to the calomel—not absolute—zero, and thus, of course, do not agree with those obtained by Mr. Campbell, since the present author's special electrolytic method is based on an almost currentless reversible electrolysis which differs widely from ordinary electrolytic methods (see, for example, *Tran. Far. Soc.*, 19, p. 692, 1924; *Rec. Trav. Ch. Pays-Bas*, 44, p. 488, 1925). The over-voltage on the pure mercury cathode beads is so large that hydrogen begins to be deposited from a deci-normal hydrionic concentration at − 1·20 v. from the calomel electrode (*Rec. Trav. Ch. Pays-Bas.*, 44, p. 503, 1925), and at the acidity of the solutions used in the dwi-manganese investigations, at − 1·3 v. to − 1·4 v., *i.e.* far behind the point of deposition of element 75. Variation of hydrion concentration from 0·1 n to neutral solution produced no effect upon the "75" hump, neither was its shape or position affected by polarising the sulphate or the chloride. Solutions of manganese sulphate which were freed from the two impurities by means of the electro-chemical deposition described in the first letter showed no hump whatever before the deposition potential of manganese at − 1·35 v.

Solutions were further obtained by subliming volatile chlorides from a fraction rich in "75," and these showed on polarograms the corresponding humps without any manganese in solution. The formation of manganese tetrachloride at the large mercury anode used in this method is out of the question, and it is equally impossible to superpose an alternating current with this delicate arrangement.

Polarograms of sodium sulphate have been frequently studied (*Rec. l.c.*, p. 493, 600), and show the same flat curve as those for sodium chloride, bromide and hydroxide.

Altogether about 400 polarograms were obtained, by the author and five collaborators working on three different pieces of apparatus in the dwi-manganese research, and checked by polarising solutions containing additions of different metallic salts to ensure that the new hump was due to a metal not hitherto identified. Whenever this hump is very prominent, the *L* lines of element 75 invariably appear in the X-ray spectra obtained by V. Dolejšek, and the combination of the two methods is now used as a guide in the analytical enriching of the solutions in element 75. Finally, the "75" hump agrees well with the deposition potentials at the dropping mercury cathode expected for the triad 25, 43, and 75, since in all analogous examples the deposition potentials of the metals in a triad become more positive by 0·1 v. to 0·2 v. with increasing atomic weight.

For a better understanding of the above explanations Mr. Campbell is referred to the seventeen papers dealing with this special electrolysis already published in English, and particularly to the Brauner jubilee number of the *Rec. Trav. Ch. Pays-Bas*, 44, pp. 488-600.

J. HEYROVSKÝ.

Institute for Physical Chemistry,
The Charles' University, Prague,
December 15.

MR. A. N. CAMPBELL in his letter to NATURE (Dec. 12) questions the validity of Dolejšek and Heyrovský's conclusions (NATURE, Nov. 28) that the second "hump" in their manganese deposition curve is due to the presence of small amounts of dwi-manganese.

In his letter Mr. Campbell assumes that the Czech authors used a platinum cathode, whereas it was Heyrovský's "dropping mercury cathode." As Mr. Campbell does not appear to be acquainted with Prof. Heyrovský's apparatus, I should like to direct his attention to an account of it in the Brauner jubilee number of the *Recueil des Travaux Chimiques des Pays-Bas* (May 1925). In his general introduction to a series of researches with this apparatus, Prof. Heyrovský pointed out, with examples, that the method he used was capable of detecting impurities down to concentrations of 10^{-6} gram-equivalents per litre. This has not been controverted.

Dolejšek and Heyrovský's interpretation that the "hump" in their manganese deposition curves was due to traces of dwi-manganese in "pure" manganese sulphate is supported by the isolation of the oxide of the new element from manganese sulphate and chloride by Mr. F. H. Loring and myself (*Chem. News*, Oct. 30, Nov. 27). By an entirely independent method we have been able to obtain about a gram of what we believe is fairly pure higher oxide of dwi-manganese.

Prof. Heyrovský's "dropping mercury cathode" does not appear to have received in Great Britain the attention it merits, although the writer of the section on general and physical chemistry in the Chemical Society's "Annual Report," 1924, mentions in connexion with it (p. 21) that there is no indication of a surface film being formed on it. This would invalidate Mr. Campbell's contention.

GERALD DRUCE.

December 14.

The Plant as a Measure of the Habitat.

IN NATURE of October 31, p. 656, appears a note concerning the plant as a measure of the habitat, wherein reference to "The Phytometer Method in Ecology," by Clements and Goldsmith, is made.

The subject of the complexity of the individual plant as a recorder is correctly touched upon, and opinion is expressed that probably it will be long ere physical instruments can be dispensed with in plumbing the possibilities of the environment

As workers in phytometry have been comparatively few, and are almost entirely American, it may be worth while to record very briefly indications as to the utility of the phytometer, obtained by me as the result of independent work.

South African native tree seedlings (*e.g.* those of *Ocotea bullata*, *Olinia cymosa*, *Olea laurifolia*, *Platylophus trifoliatus*, *Cunonia capensis*) are being tested as phytometers, the growth and transpiration responses under both natural and artificially produced habitats receiving initial attention. The results so far are distinctly favourable to the use of the plant as habitat measure; a short and preliminary account is to be published in the near future. For the forester, phytometric cultures, either free or under control, seem likely to prove valuable in returning information regarding the habitat as it impresses itself upon the plant, in throwing light on practices and processes either detrimental or conducive to the production of the optium yield from particular localities, and in indicating the species best suited to the areas to be planted.

By many it is realised that the most elaborate measurement of the physical factors of the habitat by instrumental methods usually does not even approximately inform the investigator as to the nature of that habitat as it influences the living plant itself. The plant is the truest measure of the effects of the complex produced by the integration of the several habitat factors. Provided that points of such importance as the careful selection of suitable types of plants, the employment of large numbers of individuals so that abnormal ones can be eliminated, and the study of the several responses of the plant in conjunction with physical apparatus, receive careful attention in the first instance, it does not seem too optimistic to believe that, with increased knowledge of the behaviour of selected species, the phytometer of itself will give intelligible quantitative information as to the nature of the habitat.

The value of the phytometer for analyses of habitat and vegetation processes alike is likely to be as great as the study of this grand subject is alluring.

John Phillips.

Forest Research Station,
Deepwalls, near Knysna, South Africa,
November 21.

The Principal Series of the Copper Arc Spectrum.

The second pair of the principal series of the arc spectrum of copper has been calculated by Randall (*Astro. Jour.*, 34, 1, 1911) as 2025·73 and 2024·42 (Rowland scale). Kayser and Runge (Kayser, "Handbuch der Spectroscopie," vol. 5) observed only one line at 2025·08 (I. Å.), while two lines in this region have been photographed by Rubies (*An. Soc. Esp. Y Quim*, 15, 432, 1917), and their wave-lengths given in Fowler's Report on Series in Line Spectra as 2025·1 and 2024·11 (presumably on the Rowland scale). Shenstone (*Phil. Mag*, 49, 951, 1925) in his low voltage arc work found only one line and gives its wave-length as 2024·33.

Recently in this laboratory photographs of the arc spectrum of copper under varying conditions have been taken on several large quartz spectrographs. The dispersion of these instruments at λ 2025 is approximately 0·8 mm. per Ångström unit. The exposures taken varied from 15 to 30 minutes. The current strength of the arc was 3 amperes on a 220 volts circuit.

When the middle of the arc was projected on the slit of the instrument, the 2024 line alone was recorded. When the whole image of the arc was projected, both lines were recorded, but the 2025 line was shown at the poles only. In all photographs the 2024 line was shown reversed. A plate of the spark spectrum showed only 2025. This agrees with Hasbach's spark work.

Independent calculations were made from photographs taken on three separate instruments. Interpolations were taken from a Hartmann formula based on the lines 2043·71, 2035·74 and 1999·95 (Hasbach, Kayser and Konen's "Handbuch der Spectroscopie," vol. 7). The values of the 2025 line agreed to 0·01 and those of the 2024 line to 0·02. Schumann plates were used. The following table contains our measurements, together with other known values. All wave-lengths are reduced to I. Å.

Table I.

	λ.	λ.	$\Delta\nu$
Randall (calculated) . .	2024·33	2025·67	32·7
Kayser and Runge . .	..	2025·08R	..
Rubies	2024·05	2025·04	24·1
Shenstone	2024·33	..	..
Hasbach	..	2025·36	..
Simeon and Dreblow .	2024·19R	2025·34	28·1

Our observed value of $\Delta\nu$, which is not expected to be in error by more than ±1·0, is notably less than Randall's calculated value.

From the results given above it is concluded that the 2024 line is a true arc line, being reversible and present in the centre, that the 2025 line is a spark line, and that therefore they do not constitute the second pair of the principal series.

F. Simeon.
E. S. Dreblow.

Research Laboratory, Adam Hilger, Ltd.,
24 Rochester Place, Camden Road,
London, N.W 1,
November 19.

The Action of Silica on Electrolytes.

Owing to absence from the laboratory during the summer, I have only recently been able to make experiments on the effect of silica on acids, using silica prepared as described by Prof. Mukerjee in his letter to Nature of August 29. The silicon tetrachloride was added to water in a silica dish and the mixture dialysed until the specific resistance rose to 120,000 ohms. It was then dried at the air temperature without the use of any desiccating agent. I have been unable, however, to detect in this product the slightest adsorbing power for hydrochloric acid. In his letter of April 4, Prof. Mukerjee gives figures from which I infer that he found that silica could take up more than 1 per cent. by weight of hydrochloric acid. I used one gram of silica and 100 c.c. of N/500 acid and should easily have detected the adsorption of less than 0·0004 gram hydrochloric acid (*i.e.* 0·04 per cent. by weight) by the conductance and *p*H measurements used. But not the slightest sign of removal of hydrochloric acid from solution was obtained.

I do not know whether Prof. Mukerjee has modified his views since April 4, as in his last letter the only experimental evidence suggested is that it is easier to remove traces of hydrochloric acid from silica by means of potassium nitrate solution than water. This is a very different matter from that which has been under discussion, and I will not take up space with a consideration of the various possible explanations. I am only concerned with the direct question as to whether or not pure silica can remove acids from solution, and I have been unable to obtain any evidence that it is able to do so.

One point has to be borne in mind when making these experiments: silica, prepared as above and partially dehydrated, retains much moisture (mine contained 20 per cent. after air drying for a week), which may dilute quite noticeably the solution to which it is added, and I have always corrected for this. The correction may be important in some cases, although in these experiments the quantities of reagents have been chosen so that it is very small.

A. F. Joseph.

Wellcome Tropical Research Laboratories,
Khartoum, November 10

The Evolution of the Stars.

By J. H. JEANS, Sec. R.S.

ABOUT a year ago (NATURE, December 6, 1924) reasons were given for supposing that the source of stellar radiation is to be found in the annihilation of stellar matter. Subsequent investigation suggests that the same hypothesis can clear up the puzzle of stellar evolution and of the spectral changes of a star.

In the early days of stellar spectroscopy, the spectrum of a star was believed to be an index to the star's age. That the spectra of different types of stars showed lines of, say, hydrogen, calcium, and titanium oxide, was explained by the supposition that as a star aged, its composition changed, by transmutation of the chemical elements, from hydrogen into calcium, from calcium into titanium oxide, and so on. We know better now; the researches of Saha and others have shown that a star's spectrum is an index only to the temperature of its surface. The solar spectrum shows calcium lines merely because the sun's outer layers happen to be at a temperature at which calcium atoms are very active in absorbing and re-emitting radiation; if the temperature of these layers were suddenly doubled, their spectrum would consist mainly of hydrogen lines, while if the temperature were halved, the spectrum would be dominated by the titanium oxide bands. The various types of spectra might quite well be expressed merely as temperatures, except for some outstanding difficulties as to the correct calibration of the temperature scale. Thus the problem of explaining the spectral changes of a star reduces to that of tracing out the sequence of temperatures assumed by its surface.

When we attempt to interpret radiation in terms of the annihilation of matter, the first observational fact that confronts us is that the radiations of the stars are nothing like proportional to their masses; for example, the very hot star V Puppis radiates nearly 1000 ergs a second for each gram of its mass, the sun about 2 ergs, and the earth certainly less than $\frac{1}{10000}$ erg. The transformation of matter into radiation clearly proceeds at very different rates in different bodies.

Our first impulse is perhaps to conjecture that the rate of transformation may be expedited by high temperature. But considerations of stability are found to prohibit any substantial effect of this kind. We can see in a general way that if a rise of temperature resulted in more rapid transformation, then any slight local excess of generation of energy, by raising the temperature, would force a still greater excess generation of energy, and so on without limit. Precise mathematical investigation (*Monthly Notices, R.A.S.*, October 1925, p. 914) shows that the observed stability of the stars permits of at most a very slight increase of this rate of transformation with temperature, and even this seems to be ruled out by physical considerations. Since matter is atomic, its annihilation must also be atomic, the annihilation of the smallest unit, a proton and electron, producing 0·0015 ergs of energy. This will form one quantum of radiation of wave-length $1 \cdot 3 \times 10^{-13}$ cm., which corresponds to a temperature of 7,500,000 million degrees. The temperature of a star's interior, some ten or twenty million degrees, is perfectly insignificant by comparison, and must be deemed quite incapable of affecting the process of transformation either way, at any rate by direct methods. We must accordingly suppose that matter is transformed into radiation by a spontaneous process, which proceeds, like radioactive transformations, without any regard to temperature or density. Newly generated radiation will have a wave-length of $1 \cdot 3 \times 10^{-13}$ cm. or less, but will soon become "softened" by interaction with matter and will degenerate into ordinary temperature-radiation before it has travelled far through a star. Part of the radiation generated in astronomical bodies of very low density may, however, escape into space as "hard" radiation of wave-length of the order of 10^{-13} cm.; this may be the origin of the highly penetrating radiation recently investigated by Millikan.

The great range of values of radiation per unit mass cannot, then, be traced to the variations in the physical conditions of different stars; to account for it we have to suppose that stars consist of a mixture of different types of matter which radiate at different rates, and that the proportions of the mixture vary from one star to another. Those types of matter which radiate most energetically are, of course, also those which annihilate themselves most rapidly, and so are the first to disappear as the star gets old. A young star, containing a greater proportion of these types than an old star, ought to emit more radiation per unit mass. This is in actual fact observed to be the case. Our sun, then, radiates less energy per unit mass than V Puppis simply because it is seven million million years older, and in this interval the elements which are responsible for most of the radiation from V Puppis have disappeared from the sun.

Since the process of transformation is a spontaneous one, it follows that if we know the composition of a star at birth and the rate of transformation of each of its constituent types of matter, we can trace out the changes in its composition throughout its whole life; the problem is similar to that of tracing the changes of radioactivity in rocks. Knowing the star's constitution at each instant of its life, we can, of course, deduce its rate of emission of radiation.

A mathematical study of the conditions of stellar equilibrium (*Monthly Notices, R.A.S.*, January, March, and June 1925) shows that the mass M, rate of emission E, and surface-temperature T of a spherical star in equilibrium are connected approximately by an equation of the form

$$2\tfrac{1}{2} \log E = \phi(M) + c \log T + \text{ a constant,} \qquad (1)$$

where $\phi(M)$ is a function of the mass, which is roughly proportional to $\log M$.

If this equation were accurately instead of only approximately true, the problem of tracing a star's evolution would be very simple. Corresponding to any assumed composition of the star at birth we can, as we have just seen, trace out the sequence of changes in the mass M and the emission E. At each instant the star will adjust itself so as to be in equilibrium by selecting a surface-temperature T such as to satisfy equation (1). The value of T given by this equation must accordingly determine the star's spectrum at every instant and the problem is solved.

It may seem almost incredible that the theoretical solution of the problem of stellar evolution should be so amazingly simple, yet such appears in actual fact to be the case, except for certain secondary complications, five of which we now discuss. These secondary complications impart incident and richness to the problem; it is because they intervene just where observation shows them to be needed, and because they give just the requisite modifications to the main solution, that we can feel confidence in the latter.

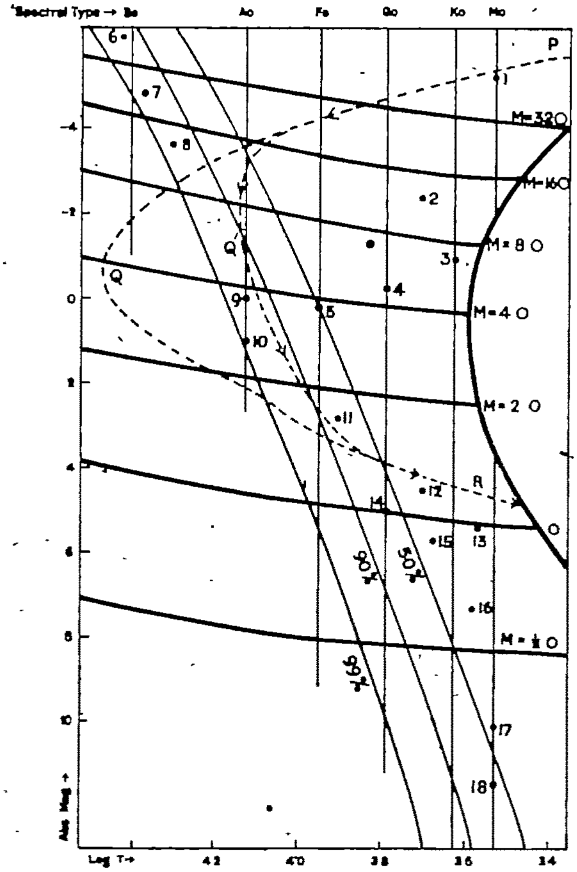

FIG. 1.—The stars, which are those shown by Russell in his diagram in NATURE (August 8, 1925), are as follows: 1, Antares; 2, δ Cephei; 3, Arcturus; 4, 5, Capella; 6, Plaskett's star; 7, V Puppis; 8, Y Cygni; 9, β Aurigæ; 10, Sirius; 11, Procyon; 12, 13, α Centauri; 14, Sun; 15, 16, ξ Bootis; 17, 18, Kruger 60.

I. Equation (1) is based on the conception of a star's interior put forward by the present writer in 1917, according to which the atoms are very largely disintegrated, as a result of high temperature, into their constituent electrons and nuclei, these now playing the rôle of "molecules" in the quasi-gas of which the star is formed. If the temperature were so high that every atom was completely disintegrated, equation (1) would be strictly accurate, c probably being equal to 2, the value given by Kramers' and Eddington's formulæ for stellar opacity. Actual stars are not so hot as this, so that c is somewhat less than 2. For average stars like our sun the value of c appears to be about unity, while for still cooler stars c may be negative.

Now the investigation of the star's dynamical stability shows that a configuration is stable (within limits to be mentioned later) if c is positive, but is definitely unstable if c is negative. A star becomes unstable as soon as it has cooled so far that c becomes negative.

The solution of equation (1) may be exhibited graphically as in Fig. 1. In this diagram $\log T$ and $-2\frac{1}{2}\log E$ (the star's absolute magnitude) are taken as horizontal and vertical co-ordinates. Equation (1) gives a value of M corresponding to each point in the diagram, so that each point represents a configuration of equilibrium for a star. The hottest stars are to the left of this diagram, the coolest to the right; the most luminous (which are also the most massive) are at the top, both mass and luminosity decreasing as we pass downwards. If c were strictly constant and positive, the curves along which M has constant values would be a series of parallel straight lines slanting upwards to the left. When the slight variations in c are taken into account, these lines run in the way shown by the thick lines in the diagram, the unstable parts for which c is negative being omitted. The thick curve on the right passes through the points at which c changes from positive to negative and so marks the limit between stable and unstable configurations.

Every astronomer will at once grasp the significance of this curve and of the hole it makes in the range of stable configurations. In 1913 Hertzsprung showed that the M-type (or red) stars fall into two clearly divided classes—stars of high luminosity which he called giants on account of their great size (a large surface-area being necessary to discharge so much radiation), and stars of low luminosity, the dwarfs. Between these two groups of stars lay a great gulf. Later, Russell, Adams, and others showed that the gulf extends to other spectral types, probably up to about $K4$. The theoretical curve which bounds the region of instability in our diagram cannot be drawn with great accuracy, but there seems little room for doubt that it must coincide with the boundary of the gulf between the giants and dwarfs. If so, there is a very simple reason for this gulf; stars cannot exist inside it because they would be unstable.

II. Every point of the diagram shown in Fig. 1 represents an equilibrium configuration for a star; as a star's evolution proceeds its representative point moves, and its evolutionary career can be recorded by a curve. On tracing out mathematically the evolution of a typical star in the way already explained, the evolutionary curve is found to be roughly parabolic and oriented like the dotted curve PQR in the diagram. The temperature of the star first increases until it attains a maximum at Q, then turns and decreases continuously, precisely as described by the "ascending and descending temperature" series of Lockyer. In time the star runs into the region of unstable configurations, as at R in the diagram.

When this happens, the star's internal generation of energy has become inadequate to supply its loss by radiation. Ordinarily a star would remedy this by expanding or contracting, but in this particular instance the star is already in a configuration in which its loss by radiation is a minimum, so that any change, whether in the direction of expansion or contraction, merely increases the rate of loss which is already too large. Equilibrium is no longer possible, and the star has to make good the deficiency in its generation of radiation by drawing upon its store of gravitational potential energy. It contracts rapidly.

The fundamental equation (1) was derived on the supposition that the gas pressure inside the star conforms to Boyle's law. The gas-molecules are, however, free electrons the diameters of which are far smaller than those of true molecules, whence it results that the stellar gas can shrink to enormously higher densities than ordinary gas before Boyle's law begins to fail. Eddington has suggested that this probably gives an explanation of the amazingly high densities observed in the stars known as "white dwarfs." The surfaces of these stars are at high temperatures and their radii so small that their densities must be thousands of times that of lead. The star the career of which we are following, when once it has become unstable, must continue to shrink until Boyle's law no longer holds, even for those absurdly small molecules, the free electrons. It becomes a white dwarf.

Thus our scheme of stellar evolution demands white dwarfs and provides a niche into which they fall naturally and inevitably. At the same time it suggests views of the physics and evolution of the white dwarfs which differ somewhat from those hitherto held. Eddington and Russell have considered the white dwarfs merely as extreme cases of ordinary stellar configurations. That the two or three white dwarfs so far detected are comparatively similar to one another must, on their view, be regarded as accidental. Our theory, on the other hand, implies that the white dwarfs form a separate and detached colony; they ought all to be rather like one another, and there should be no continuity with ordinary stars. As regards their evolution, the white dwarfs have been described as the oldest stars extant, "vestiges of an earlier creation," and so on. Our view of their evolution implies that they are neither older nor younger than the great majority of stars; they have merely been more unfortunate. The white dwarf state is a sort of bankruptcy court into which a star falls when it is unable to make both ends meet in the matter of radiation. When the original Sirius broke up into Sirius *b* and Sirius *f*, the former contrived to keep most of the matter which was easily transformable into radiation, hence the present splendour of Sirius *b* and the unhappy condition of Sirius *f*. In such cases as α Centauri and Kruger 60 there appears to have been a fairer division of radiation-producing material.

III. The typical evolutionary path PQR in our diagram penetrates regions near Q in which no stars are found. A star at Q would have practically all its atoms stripped bare of electrons, while calculations on actual stars show that very few have more than about 95 per cent. stripped bare. (The slant lines in the diagram show the proportion of bare nuclei calculated for an assumed atomic number 20.) The obvious interpretation of the observed facts is that in some way the evolutionary paths are turned before they reach regions of, say, 99 per cent. of nudity.

If the annihilation of matter is a quantum process of the kind I originally conjectured (Nature, December 6, 1924) this would happen automatically, for the baring of each nucleus would represent a loss of energy-generating power, and a star with all, or too many, of its nuclei stripped bare would leave off generating energy until sufficient atoms had re-formed. The typical evolutionary path in our diagram must no longer be taken to be PQR, but some such path as $PQ'R$.

The belt of configurations in which, say, from 80 to 99 per cent. of the nuclei are bare forms a sort of common envelope to most of the evolutionary tracks in the diagram. There ought then to be a great concentration of stars in this belt. This is in agreement with what is observed, for the calculated position of the belt, as shown in our diagram, coincides very closely with that of the main sequence of Eddington and Hertzsprung, which, besides forming a boundary in the direction of high temperature, is conspicuous for its great concentration of stars.

IV. It can be shown (*Monthly Notices, R.A.S.*, June 1925) that when a star breaks into two by fission, each constituent must assume a higher temperature than the original temperature of the parent star. The increase of temperature is generally sufficient to throw both constituents into the main sequence, after which the loss of energy-generating power will, as already explained, prevent their becoming still hotter. This explains why both constituents of newly formed binaries are generally found to lie in the main sequence.

A star such as Antares (No. 1 in Fig. 1) may reach the main sequence by travelling along a normal evolutionary path such as PQ' for about a million million years, or, in the event of fission occurring, may jump to it almost instantaneously, forming a binary star such as V Puppis (No. 7 in Fig. 1).

V. The stars in the region of P in our diagram are red giants of enormous size and very low density; they are almost all variable stars. Mathematical analysis shows that stars in this region may be affected by a special type of instability, not so far mentioned. This would show itself in a tendency to develop pulsations of practically unlimited amplitude, and there appears to be some prospect of explaining long-period variability in this way. The short-period variables and the Cepheids may possibly be stars actually in process of fission, as is suggested by their position in the diagram. Such conjectures need to be tested very thoroughly before they can be accepted, but it is at least clear that the proposed theory of evolution provides a place quite naturally for these two main types of a stellar variation.

Each of the foregoing modifications of the simple theory has been demanded by theoretical considerations, and each has been found to provide a natural, and almost inevitable, explanation of one outstanding feature of observational astronomy, as follows:

I. Giant and dwarf stars.
II. White dwarfs.
III. The "main-sequence."
IV. Early spectral types of newly-formed binaries.
V. Variable stars (conjectural).

It seems fair to say that no other theory of evolution gives a tenable explanation of even any one of these five features. This is the case for the proposed theory.

If a star, in breaking up by fission, divided its different ingredients proportionally between its two constituents, it is easily shown (*Monthly Notices, R.A.S.*, June 1925) that the fainter constituent would be of earlier spectral type than the brighter. This arrangement prevails in many newly formed binaries, but not in all (*cf.* Leonard, *L.O.B.* 343, 1923), and it is clear that in many cases, as in that of Sirius already discussed, the more massive constituent must have kept an undue share of highly radiating material; an extreme case of this kind is provided by the sun and earth. The situation is consistent with the supposition that the highly radiating material is of exceptionally high atomic weight and is therefore left in the more massive star when the lighter one is formed by drawing off the outer layers of the original star. Newly created matter probably contains elements of atomic weights far higher than any known on earth; it may even consist entirely of such elements. Our terrestrial elements are merely a residue of material which is practically non-transformable—dead ashes for the most part, although possibly the radioactive elements still retain some vestige of the powers of primeval matter. For one brief moment it seemed possible that cosmogony might teach us how to obtain almost boundless supplies of energy by the annihilation of quite insignificant fragments of matter, but this apparently is not to be. So far as we can at present see, Nature has arranged that the energy-producing elements shall be kept out of the reach of man; while he may watch the process of transformation going on in the stars, he will never be allowed to operate it himself. Whether this is to his advantage or disadvantage, who shall say?

The Relative Age of Rocks containing Fossils.

By Sir ARTHUR SMITH WOODWARD, F.R.S.

DURING recent controversies as to the evidence for the evolution of life in past ages, it has been stated that geologists arrange the fossil-bearing rocks in a "purely artificial" manner, not necessarily in the order in which they are found superposed. It has even been asserted that when the fossils occur in successive layers in an order which an evolutionist would say is the reverse of that expected, the rocks are assumed from this criterion alone to have been disturbed and turned upside down. The progressive development of life which a geologist recognises, indeed, is said to be imaginary and not proved by the observed order of superposition of the rocks.

Such statements are based on a complete misunderstanding of the facts. The science of geology originated, and the order of nearly all the principal layers of sedimentary rocks was first determined, on the unstable western edge of the continent of Europe. In this region from the beginning of geological time there have been frequently repeated downward and upward movements leaving records in sediments of the successive seas which overflowed and retreated. The sedimentary rocks have been tilted and their edges worn away in such a manner that their order, or relative age, is easily observed. Their succession in fact is so clear that it has been possible in several cases to follow the changes of material in one and the same layer—the sands and gravels which were deposited near the shore, the mud farther out, and the remains of calcareous skeletons forming limestone in the clear water of the open sea. As an illustration may be mentioned the lower Carboniferous deposits, which are open sea limestones in central England but gradually pass into estuarine sands and clays with beds of coal in the south of Scotland, where there are only occasional beds of limestone containing approximately the same fossils as the great marine deposits farther south. More than a century ago, when almost all naturalists believed in "special creation" and there were no accepted theories as to the order of "creation," the succession of the rocks in England and Wales was made out by William Smith from actual observation of their superposition. Later geologists merely elaborated details, and made more extensive collections of fossils. Geologists on the present European continent found the same general succession in their several countries, only varied by local circumstances; some additional layers being intercalated in the typical British series, others omitted, and some being represented by different rocks. Allowing for the differences in sediment and its amount which would be deposited in different parts of the same sea and adjacent estuaries, the succession was discovered quite clearly by observations in the field.

It was not until the field-work was far advanced that the fossils were studied in detail and found to indicate distinct progress in the development of life on the earth. None but animals without a backbone have ever been found in the oldest fossiliferous rocks; fishes are known to have flourished long before any lung-breathing backboned animals; the cold-blooded amphibians and reptiles came successively before the warm-blooded birds and mammals; man appeared at the end. In several groups, too, fossils collected from rocks of which the relative age is definitely known from observation of the layers in the field, show that the lower grades appeared before the higher grades. This became evident so long ago as 1836, when Buckland in his Bridgewater Treatise remarked on the interest of the oldest known mammals from the Stonesfield Slate of Oxfordshire as belonging to the lowly pouched group of marsupials. He stated that "the analogies afforded by the occurrence of the more simple forms of other classes of animals in the earlier geological deposits would lead us to expect also that the first forms of Mammalia would have been marsupial."

When geologists began to study the marine fossil-bearing rocks in other parts of the world, especially North America, they discovered differences in detail, as might have been expected—differences both in sediment and in fossils. In all cases, however, where the order of superposition of the layers could be clearly observed, the succession of the various groups of fossils was proved to be essentially the same as in western Europe. Rocks containing approximately the same fossils in widely separated regions may not have been contemporaneous in formation; judging by the

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distribution of life in the sea at the present day, they were probably not strictly contemporaneous. Always, however, when sections of the rocks can be studied, the various fossil-bearing deposits are found to be in the same order. The only apparent exceptions to this rule are comparatively local and in regions which show some signs of disturbance. Among the folded rocks of mountain regions, for example, the layers are sometimes overturned; while in districts where soft deposits have been squeezed by the passage of ice over them, they are sometimes broken up into patches which may be pushed together into heaps, not always in the original order.

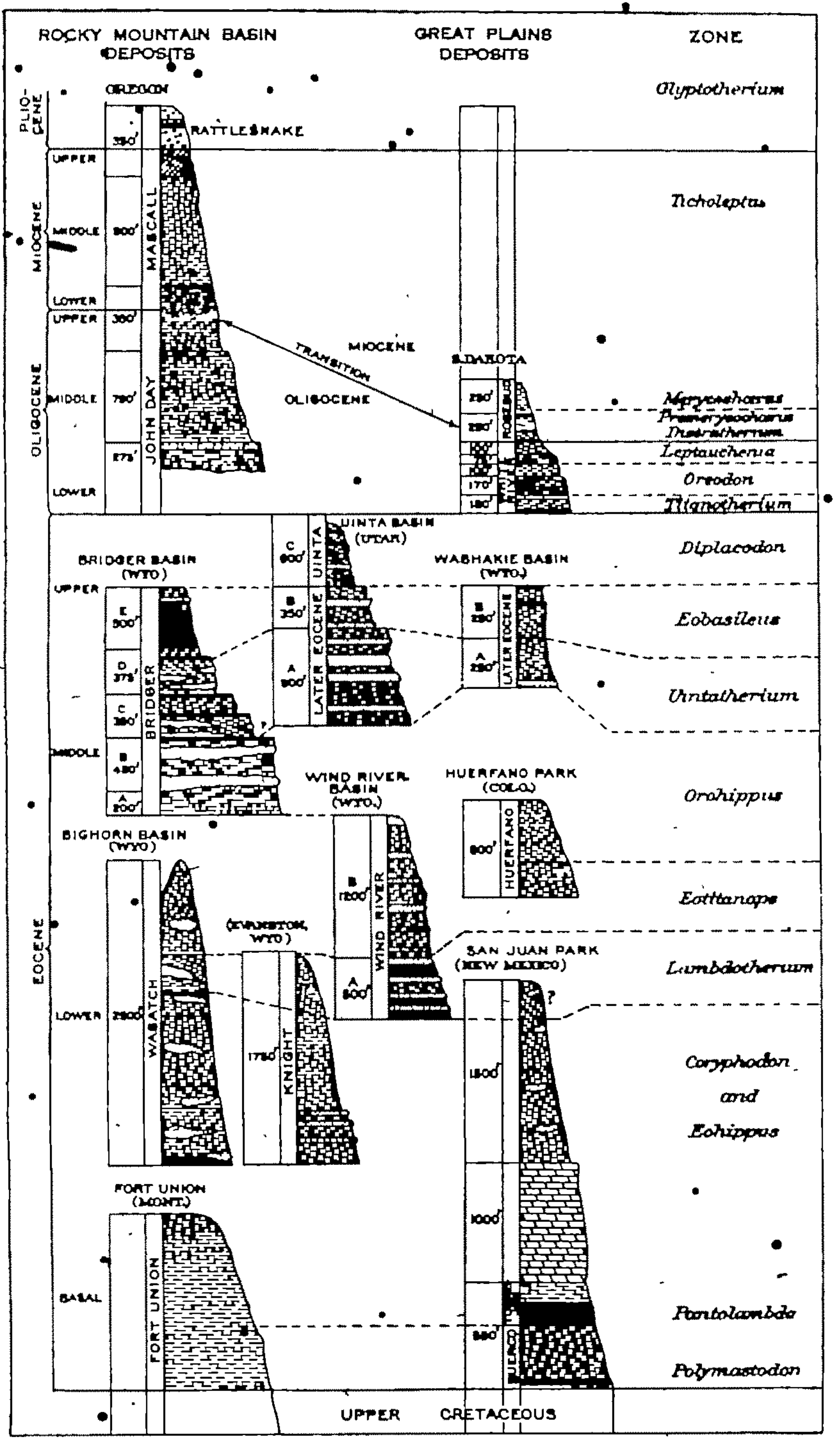

FIG. 1.—A series of sections of the Tertiary land and freshwater deposits containing fossil mammals in western North America, showing how one section can be correlated with another by noting the successive specially characteristic genera which are enumerated in the column to the right. After Henry Fairfield Osborn (*Bull. U.S. Geol. Survey*, No. 361, 1909).

The softness or hardness of a deposit is no criterion of its geological age, but depends merely on local circumstances. For example, on the coast of the Baltic Sea near Reval there is a soft clay which looks like a modern deposit; but it contains some of the oldest fossils characteristic of the Cambrian period, and it is shown in some places to be overlain by fossil-bearing limestones which prove that it is really of Cambrian age. Again, in Canton Glarus, Switzerland, there are hard slates of ancient aspect which are shown by their position to be of Tertiary age, and their contained fossil fishes much resemble those of which fragments occur in the Lower Tertiary clays and sands of south-eastern England. There can be no doubt that these two very different series of rocks are at least in part contemporaneous.

There must naturally be numerous gaps in the series of sea-deposited rocks in every part of a continental area, representing periods when the region was dry land or perhaps covered by water in which there was no sediment. Sometimes the elevation or depression of the land occurs without any tilting, and then, unless an old land-surface is marked by remains of vegetation (as in coal seams and in the fossil forest of the Isle of Purbeck and Portland), it can only be recognised by studying the fossils in the rocks above and below. In Morayshire, Scotland, for example, there is a thick regular series of sandstones, the lowest containing Devonian fishes, the uppermost Permian or Triassic reptiles, with no indication of the long coal period which rocks farther south prove to have intervened between the time of deposition of these two directly superposed sandstones. It is only after long and wide experience of the succession of the rocks in different parts that such "deceptive conformities" can be detected.

It must, indeed, be repeated and emphasised that the whole succession of the marine fossil-bearing rocks in western Europe—the most favourable region in the world—had been clearly ascertained before the idea of organic evolution was accepted by geologists. Fossils were appropriately termed "medals of creation" and were merely used as time-markers in cases where the superposition of the layers was obscured. In spite of earlier discussions, it was only after the publication of Darwin's epoch-making work in 1859 that the meaning of the order in which fossils were known to occur became evident. Group after group was studied from the new point of view, and the study is still in progress. The result is complete confidence in the "evolutionary stages" of all groups of organisms as guides to the relative geological age of rocks which contain them in any part of the world.

This result is important because a large proportion of the land and freshwater deposits of the latest or Tertiary epoch are comparatively limited in extent and thickness, and completely isolated on continental areas which have scarcely been affected by movements since they accumulated. These contain the remains of the ordinary land mammals from their beginning until the present day; and the mammals exhibit the most striking evidence of descent from a common ancestry of any forms of life. At first, especially in North America, it is perhaps true that confidence in the general principles of evolution led to some reasoning in a circle. When collections were made in the territories of hostile Indians there was not much opportunity for detailed field observations. In later years, however, circumstances have improved and experience has been gained, and not only in North America but also in other countries fossil mammals have been collected from beds which have been definitely observed to repose one on another.

Furthermore, there has been much certain correlation by the deposits of one isolated area, as shown by the fossils, overlapping in time the deposits of another isolated area. In illustration of this, Prof. Osborn has published the accompanying diagram (Fig. 1), which explains itself. The general evolution of the horses and camels in North America has thus been revealed, not by assuming the relative age of the beds of different areas in which their fossil remains occur, but by actual correlations made by geologists in the field. Similarly, the relative ages of the primitive ancestors of the elephants in Egypt have been ascertained by examination of perfectly clear geological sections. So many observations of this kind have now been made in various parts of the world, that palæontologists have no longer any hesitation in determining the age of an isolated Tertiary deposit by the state of evolution of the fossil mammals which it contains. They are perfectly justified in doing so, in view of the definite geological evidence which is forthcoming in so great a multitude of cases.

The evolution of life as revealed by fossils is not, therefore, a phantom arising from excess of zeal in pursuing a fascinating idea. It is as strictly the outcome of purely inductive science as any other great generalisation.

Obituary.

MR. W. P. HIERN, F.R.S.

WILLIAM PHILIP HIERN, whose death took place at the Castle, Barnstaple, on November 29, was best known for his work on systematic botany. The son of J. G. Hiern, he was born at Stafford on January 19, 1839, and entered St. John's College, Cambridge, in 1857, where he graduated B.A. as ninth wrangler in 1861, proceeded to M.A. in 1864, and was a fellow of his college from 1865 until 1868. In 1868 he incorporated as M.A. at Christ Church, Oxford, about which time he became interested in botany, and in 1873 published in the *Transactions of the Cambridge Philosophical Society* a monograph of the Ebenaceæ. He then went to the Royal Botanic Gardens, Kew, where he worked out the Meliaceæ and Sapindaceæ for Hooker's "Flora of British India," and was responsible for the greater part of volume 3 of the "Flora of Tropical Africa" in 1877, the Umbelliferæ, Araliaceæ, Rubiaceæ, Valerianaceæ and Ebenaceæ of which he worked out alone, and the Compositæ with Prof. D. Oliver.

A law suit, which had been commenced in 1873 by the King of Portugal against the executors of Dr. Friedrich Welwitsch, who had made botanical collections in Angola on behalf of the Portuguese Government, terminated in a compromise in 1875, and Hiern was appointed by the Court to separate a set and to copy the field notes on behalf of the British Museum. This he proceeded to do, and between 1896 and 1900 published in four parts a "Catalogue of the African Plants collected by Dr. Friedrich Welwitsch in 1853–1861." This completed the account of the dicotyledons, and the remainder of the catalogue was published by members of the British Museum staff. In the *Journal of Botany* for 1895, pp. 139-141, he published a note on the "Plants of Welwitsch's Apontamentos." In conjunction with C. Ficalho he worked out a collection of African plants on which a report, entitled "On Central African Plants collected by Major Serpa Pinto," was published in the *Transactions of the Linnean Society* in 1881.

Having completed his work on the Welwitsch collection, Hiern again went to Kew, where he elaborated the account of the Scrophulariaceæ of South Africa, which in 1904 occupied pp. 121-420 of volume 4, part 2, of the "Flora Capensis," after which he found himself unable to undertake further work on African botany, which was offered to him at Kew. He then retired to Barnstaple and kept the botanical records for Devon, and published in the Botanical Exchange Club Report, 1918, p. 414, a "Clavis to Devonian Sedges," based on the structure of the stems and leaves. During this period he devoted his attention to public affairs and became a Justice of the Peace and County Alderman for Devon.

Mr. Hiern was elected a fellow of the Royal Society in 1903 and of the Linnean Society in 1873; he was also a corresponding member of the Royal Academy of Lisbon. He was a widower, and his only son died some years ago.

C. H. W.

Views and News.

THE annual report of the Development Commissioners which has recently been issued is, as usual, extremely well documented. It contains *inter alia* detailed notes on the work of each of the institutions in receipt of grants for agricultural research and the closely allied " advisory " work. Full details are also furnished regarding the other than purely agricultural agencies, such as the Fishery Department, Rural Economy (as represented by the Rural Industries Bureau), and the Construction and Improvement of Harbours. The introductory portion of the report is devoted to a discussion of the question how far the expenditure by the State of a sum approaching half a million sterling annually is justified by the material progress made in the arts of husbandry. While it is true that " agriculture now requires as much aid as can be got by it from modern science," it is perhaps disappointing to observe that the Commissioners do not stress what, for want of a better epithet, may be termed the spiritual value to agriculture of education and research. If one reflects that the industry is predominatingly one which is dominated by tradition, it is surely no mean feat to have made some progress—to which the labours of the Commissioners have largely contributed—in convincing the agriculturist that the scientific method and the scientific spirit stand for progress, and that all knowledge is not crystallised in the experience of our forerunners. There is little need to deplore the " slow result being secured in the improvement of agriculture " if the Commissioners are satisfied that, with the aid of the advances made by them, new scientific discoveries —new knowledge of truth—have been achieved.

THE Commissioners are on surer ground when they say that " although the present system of agricultural education represents the growth of 35 years, it is only within the past ten or fifteen years that competent instructors [*Sc.* in the scientific principles of husbandry] have been available." It may, in fact, be counted as one of the most notable achievements of the Commissioners that they have promoted measures which by means of scholarships and otherwise have tended to recruit more competent workers to the field of the developments in which they are interested. The report closes with a statement of the finances of the Development Fund, showing that on April 1, 1924, the balance at credit was 320,000*l*. Receipts during the year amounted to 218,000*l*. Payments totalled 314,000*l*, leaving a balance at the end of the year of 224,000*l*. The payments include one of 78,000*l*. to the Irish Free State, presumably in final settlement of its " moral and material " claims against the Fund. In addition, the accounts of the Special Fund (representing the moneys secured under the Corn Production Act) show an expenditure of 152,000*l*. and a balance of 537,000*l*. The Commissioners do not say whether, as may be hoped, their balances are sacrosanct to the Chancellor of the Exchequer.

IT is announced by the Smithsonian Institution that from January 1, 1926, the Institution will furnish gratis to certain American organisations, daily or ten-day mean values of the " solar-constant " of radiation as early and as frequently as results are available from the field stations in Chile and California. In general, results are available about 24 hours after the field observations. The Institution declines, however, to furnish data of this kind regularly to individuals. From the circular in which this announcement is made, we learn that the Smithsonian Institution is concentrating attention on the measurement of radiation. The close study of the relation between radiation and weather is to cease on account of lack of funds. The yearly cost of Mr. Clayton's researches has been approximately 7500 dollars. The generosity of Mr. J. A. Roebling has permitted the Smithsonian Institution to carry them on for the past two and a half years, but that support will cease at the end of this year. Even those who are most sceptical as to the immediate value of the attempt to utilise day-to-day observations of the "solar-constant" in weather forecasting will regret that the work organised by Mr. Clayton is to lapse at the very time when his success is being proclaimed so widely by the Institution.

THE radiation observations of the Smithsonian Institution are made at observatories on mountain tops in desert regions, such sites being chosen so as to give clear dry air and freedom from cloud. The observers are exiled for long periods, to live under conditions that must be anything but pleasant, with little company and none of the recreations of the garden or the field. There is one station at Mt. Montezuma, in the Chilean Andes; the other has just been removed from Harqua Hala, Arizona, to Table Mountain, California. The National Geographic Society has now given 55,000 dollars for the establishment of a third; Dr. C. G. Abbot's recent visit to Great Britain was at the beginning of a tour in which he hopes to select a site in Morocco, Beluchistan, or Tanganyika. It is rightly felt that the establishment of a station in the eastern hemisphere is essential if there are rapid day-by-day fluctuations in the solar heat stream to be investigated Even for the determination of slower variations, the elimination of atmospheric effects peculiar to different parts of the globe is necessary. It is therefore welcome news that this extension of the observing system is being made.

THE Société d'Encouragement pour l'Industrie nationale of France, in view of the important advances which have been made in the last ten years in establishing meteorology on a firm scientific foundation, and of the importance of the subject as one on which the national wealth depends, organised in May last a series of seven public lectures on its recent progress and on its applications These lectures were delivered by some of the most distinguished of the meteorologists of France, and are reproduced in full as the July-August-September issue of the *Bulletin* of the Society. They occupy 120 pages, and are followed by a list of recent French books on the subject, with a page or two of description of the method of treatment adopted in the more important. The lectures deal with the general facts of meteorology, forecasting with special reference to the methods adopted in France and in Norway, applications in aeronautics, wireless telegraphy, navigation, agriculture, and medicine, and with the proper organisation of a national forecasting service.

THE Duddell Medal of the Physical Society of London has this year been awarded to Mr. Albert Campbell, formerly of the National Physical Laboratory. The medal is awarded to those who have advanced the science of physical measurements by inventing instruments or parts of instruments of novel design. Mr. Campbell has won distinction for many new devices connected with the measurement of capacity and inductance. He was one of the first to introduce coils of small self capacity now so largely used in wireless; Campbell's system consists of a number of pancake coils separated from one another by small spaces and held rigidly together. Mr. Campbell has invented instruments for the measurement of frequency, others, known as wave sifters, for the elimination of particular frequencies, instruments, called microphone hummers, for the production of small alternating currents, and vibration galvanometers for use in measurements employing alternating current. The instrument for which he is best known is the standard mutual inductance which forms the basis of most of the accurate measurements of inductance in Great Britain. Mr. Campbell is well known for his skill as an experimenter and has made two determinations of the ohm in absolute units.

FOR some years the Canadian Government has been paying increasing attention to the economic potentialities of the Arctic archipelago. The dispatch of exploring expeditions and the establishment of police posts in the far north are evidence of this new interest. A special publication of the North-West Territories branch of the Department of the Interior entitled *Canada's Arctic Islands* gives an account by Mr. J. D. Craig of the work of the expedition of 1922. The scientific interests of the pamphlet lie mainly in the remarks concerning aviation in the Arctic. Major R. A. Logan, of the Canadian Air Force, who accompanied the expedition, believes that there are many places in the archipelago suitable for aerodromes, thus obviating the necessity of using hydroplanes, which are a danger because of the fragments of ice, frequently almost invisible from a height, that often occur in apparently open water. He thinks that the end of May, June, July, and part of August are almost ideal for navigation on account of weather and continuous daylight, and recommends the use of aeroplanes for survey and patrol work. Major Logan advocates the establishment of an experimental air station, with two small machines, at the police post at Pond's Inlet in northern Baffin Land. This would give valuable experience on which to base more extensive work.

A CORRESPONDENT refers to the difficulty he experiences in preventing fracture of the tinted glass in the sun-cap of his telescope when used for solar observations. The heat absorption of the neutral tinted glass frequently used for this purpose is about three times that of the glasses of which the lenses are made. The tinted glass thus experiences considerable heating effect and, as it possesses no compensating advantage in regard to thermal expansion, there is consequently increased liability to fracture. When a solar prism is used, only about 5 per cent of the heat incident on the prism is reflected into the eye-lens, and in the polarising eyepiece the heat is largely absorbed by the four reflecting surfaces. If neither of these devices is used, it is necessary to limit the amount of heat transmitted by cutting down the aperture of the object-glass to about 2 in. Precautions should also be taken to minimise the stresses set up in the tinted glass on being heated. The glass disc should not be a tight fit in the cell, nor should it be tightly screwed or bezelled in. The thinner the disc is the more readily will equalisation of temperature throughout the glass be obtained. If a thin disc does not provide sufficient absorption, it is advisable to use two such discs rather than a thick one. As a further aid towards securing equalisation of temperature, the disc should not be larger than is necessary to cover the required field. It is possible that, for solar observations, platinised glass discs might advantageously be used in place of tinted glasses. The film of platinum would act as a conducting layer and thus prevent excessive local heating. If necessary, the discs could be made of heat-resisting glass or even of quartz. These platinised glasses have the additional advantage that the absorption produced is almost uniform over the whole visible spectrum, which is not always the case with tinted glasses.

THE photo-electric cell is being studied by engineers as well as by scientific men all over the world. In the newest developments of the methods of sending pictures by wires or through space by radio waves, this cell is an essential device. There are many other applications of it. In *Popular Radio* for November an apparatus is described for sorting out cigars according to colour by means of it. A beam of light is reflected from the cigar into a photo-electric cell. The alteration in the electric current actuates a relay operating mechanism which separates the cigars into three groups, light, dark, and red, according to their shade of colour. The device that has been used to measure the light coming from stars or the light needed by plants is now rapidly being applied to all kinds of commercial uses. In particular, it has recently been found most useful for measuring the intensity and quality of the light emitted from luminous sources, and much research is being carried out in this direction. The "phototron," which is a type of photo-electric cell largely used in the United States, is in appearance like an ordinary radio valve and is mounted on the standard radio valve base. It consists of a plate on which a coating of active alkali metal, generally potassium, is placed. In front of the plate there is a wire grid which serves to collect the electrons. Two of the wires connect to the grid and the third to the plate. The whole is enclosed in a glass bulb which is exhausted of air. When light strikes the plate of potassium electrons fly off. The number of these free electrons is roughly proportional to the intensity of the light. The grid being maintained at a high positive potential relative to the plate attracts the electrons to itself and they can be returned to the plate through a galvanometer. The photo-electric current through the galvanometer measures the number of the electrons. For certain purposes the photo-electric cell may serve as a "radio eye," and the human eye itself may possibly be a living photo-electric cell.

We learn that Max Møller, of the University of Copenhagen, Denmark, has taken up the post of visiting professor of chemistry at the Chulalongkorn University, Bangkok, Siam, under the auspices of the Rockefeller Foundation of New York.

We learn from *Science* that Dr. John J. Abel, professor of pharmacology at the Johns Hopkins Medical School, will receive the first 2500 dollars annual award of the Research Corporation of New York, as an investigator who has made "outstanding contributions to the cause of science without profit to himself."

We understand that, having completed his work on the Atlantic eel, Dr. Johs. Schmidt, Director of the Carlsberg Laboratory, Copenhagen, is now taking up the study of the eels of the Indo-Pacific area. He is leaving in the course of a few days on an expedition to the Pacific to collect specimens and make observations, and expects to be absent for about six months.

Prof. J. W. McBain, Leverhulme professor of physical chemistry in the University of Bristol, will deliver a course of lectures on colloid chemistry at the University of California, Berkeley, Cal., during the first part of 1926, and he will be the guest of honour at the National Colloid Symposium to be held in June at Cambridge, Mass.

Prof. Paul Sabatier, professor of chemistry in the University of Toulouse, and Prof. E. L. Bouvier, professor of zoology (entomology) in the National Museum of Natural History, Paris, have been elected associates of the division of sciences of the Royal Academy of Sciences, Letters and Art of Belgium; Prof. Marc de Sélys Longchamps, of the University of Brussels, has been elected a corresponding member of the Academy.

A. Shimomura has published in the Memoirs of the College of Science, Kyoto Imperial University, Series A, vol. 8, No. 6 (August 1925), an account of the low temperature carbonisation in Fischer's aluminium retort of sixteen coals of oriental origin. The samples ranged from bituminous coals, with more than 40 per cent. of volatile matter, to anthracites. From analyses of the coal and the yields of the various products, it is clear that there are some excellent fuels available in the East.

In pursuance of the policy of carrying out a physical and chemical survey of the national coal resources of Great Britain, which is one of the main aspects of the fuel research work of the Department of Scientific and Industrial Research, a committee has been appointed to deal with the physical and chemical survey of the coalfields of Scotland. The committee includes representatives of the coal owners of Scotland, the Mining Institute of Scotland, the Scottish branch of the Geological Survey, and the Fuel Research Board. Similar committees have already been established in the Lancashire and Cheshire, South Yorkshire, and North Staffordshire areas in England.

The issue of the latest annual report of the Technological Museum of Sydney, N.S.W., in the form of type-written sheets, indicates financial stringency, and this is also evident in the body of the report. None the less, much good work appears to be in progress, and it is particularly pleasing to find recorded a general increase in the number of applications for material for school museums. The museum has not only supplied exhibits to the schools, but has also encouraged teachers to interest their pupils in collecting local specimens and in sending them to be named and classified. This serves a double purpose: the pupils' knowledge of botany, geology, and local products is increased, while the school museums are built up by their efforts, and a keener interest created.

An address delivered at a birth control conference in New York last March by Dr. Louis Dublin, Statistician to the Metropolitan Life Insurance Co., New York, which appears in *The World's Health*, vol. 6, No. 12, p. 505, is of some interest in connexion with the recent correspondence on the subject in Nature. Dr. Dublin is an opponent of the broadcasting of contraceptive information without reserve, on the grounds that propaganda have been elaborated prematurely (1) without due regard to the permanent interest of the State, (2) without adequate consideration of the real population tendencies which to-day prevail, and (3) without sufficient regard to the trustworthiness and safety of the procedures recommended and to the consequences on the spiritual life of those who are influenced by the advice tendered.

The University of Masaryk, at Brno (Brünn), issues a number of separate papers describing work carried out at the University under the general title "Publications de la Faculté des Sciences." Several botanical communications in this form have recently been received. These include systematic works, such as a revision of the genus Onobrychis (in Latin), by G. Širjaev, an account of the Compositæ collected in Turkey and Persia, by Dr. Fr. Nábělek (also in Latin), a phytogeographical study of the distribution of lichens in Moravia by Jindřich Suza (in Czech with an English summary); and two publications from the Laboratory of Plant Physiology, namely, (1) on growth reactions produced by change of pH on roots of *Pharbitis hispida* Choisy (in English), by Ferd. Herčík, and (2) on the growth of structures formed by boundary reactions between solutions of electrolytes in gelatin and in water, by Vladimír Morávek (in Czech with English summary).

In the case of the Mollusca, almost more than in that of any other group of the Invertebrata, are figures necessary accompaniments to descriptions of new species, owing to the extreme difficulty of defining satisfactorily their appearance by words alone. Some societies, like the Malacological Society of London, make a practice of giving figures with all new descriptions, but that wise course is far from being so universal as it should be, while in the past it has been neglected to a lamentable degree. Conchologists, therefore, owe a great debt to the veteran Dr. W. H Dall for his "Illustrations of unfigured Types of Shells in the Collection of the United States National Museum" (*Proc. U S. Nat Mus*, 66, Art. 17), to which have been added a few figures of species elsewhere inadequately illustrated or depicted in publications difficult of access, as well as descriptions and figures of 17 new species The work comprises 36 plates giving figures of some 200 species, and 41 pages of text confined mostly to references to the original descriptions. The figures, which were drawn as opportunity offered and put aside until publication could be made, are in different styles and reproduced by several different processes, and are all very good and clear despite the sacrifice of pleasing uniformity.

THE sixth of the booklets, 14 cm. × 11 cm., issued by the Cambridge Instrument Company, describing the firm's productions, contains 64 pages, and is devoted to instruments which have been at various times designed for special purposes. In each case a photograph of the instrument described is given, and as a rule its over-all dimensions are recorded. The first portion of the booklet is devoted to magnetographs of various types, to Galitzin seismographs, and to tide recorders. Then follow spectrographs ranging from the infra-red to the ultra-violet, astronomical and sunshine recorders, X-ray track apparatus, comparators for the accurate measurement of standard tapes for geodetic surveys, deflexion and crack meters for investigating the strains in structures, permeameters for measuring the flow of gases through fabrics, sound-ranging apparatus as used in the War, and pressure recorders for use in coal-dust explosion tests. Brief notes are supplied as to the capabilities of each instrument, but more detailed descriptions are available, on request, for the use of those who require further information.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned —A professor of biology and a professor of bio-chemistry in the College of Medicine, Singapore—Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S W.1 (January 9). A research chemist, with knowledge of the clay industries, and research experience in connexion with clay and clay products, at the Building Research Station, Garston, Watford, of the Department of Scientific and Industrial Research—Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S W.1 (January 11). Head of the Engineering Department at the L.C C. Hackney Institute, Dalston Lane—Education Officer (T (1) (a)), The County Hall, Westminster Bridge, S E.1 (January 18) An assistant lecturer in Economics at University College, Southampton—Registrar.

Our Astronomical Column.

SUNSPOT DATA FROM CHINA.—Solar observations have been carried out systematically and with great zeal for many years at the Zô-Sè Observatory, China, under the direction of Father Chevalier of the Jesuit Mission at Shanghai. Vol 14, No 1 of the *Annals* of this observatory contains lists of sunspots and of prominences observed during the three years 1920, 1921, and 1922 The heliographic co-ordinates of the spots, date and hour of meridian passage, observed areas, and other data are carefully recorded, and in the case of the prominences the latitudes, heights, areas, and relative brightness are tabulated Apparently the opportunities for successful observation of prominences are limited to about sixty days annually, but these observations will nevertheless be of considerable value in co-operation with visual observations made elsewhere.

In discussing the results of the sunspot data, Father Chevalier concludes that spots do not appear at random in different regions of the sun's surface, but tend to develop in certain areas over considerable periods of time When the observations of latitude and longitude are plotted over long periods of time, there is thus a tendency to form groups, and these sometimes tend to be drawn out obliquely with reference to the meridians, as though the foci of activity moved slowly in longitude towards east or towards west

The remarkable interchange of activity between the northern and southern hemispheres, and the varying positions of the equatorial zone of minimum activity, are also brought out in these studies.

THE PHYSICAL NATURE OF THE SOLAR CORONA —The *Zeitschrift fur Physik* of October 20 contains the second part of a paper on the above subject by Dr. W Anderson, with a discussion of the photoelectric and the electromagnetic theories of the corona, both of which he shows lead to great difficulties The observations of H. Ludendorff during the solar eclipse of September 10, 1923, are referred to; they show that the maximum of intensity in the spectrum of the corona coincides exactly with that in the spectrum of the photosphere, which is contrary to results previously obtained, and shows that the corona does not consist of incandescent particles, since the temperature of such particles would certainly be lower than that of the photosphere, and the intensity maximum would be shifted towards the red. Dr Anderson proceeds to obtain an estimate of the effective molecular weight of the corona, based on the fact that since the pressure is small the mass absorption coefficient and the temperature radiation are small, so that alterations in state must be adiabatic. He estimates the temperature in the lower layers as 4824° Abs., which leads to a maximum value of the effective molecular weight, m, of 1/1733·5 and a minimum of 1/1906·8, in the highest regions the temperature estimate is 4236° Abs. and m lies between 1/1787·7 and 1/1985·1, with similar values for intermediate heights. According to L Flamm, the "atomic weight" of "electron gas" is 1/1832·8, which lies between these maxima and minima.

Research Items.

Some Hindu Observances.—In the *Scientific Monthly* for December, Dr. Elsie Clews Parsons records autobiographical reminiscences of Somesh Chandra Bose, a Bengali of the Kshattriya caste. His family are Kulin Kasyathas and his wife was Bal, a division of the Kasyathas for whom it was an honour to intermarry with the Boses, their superiors. His own immediate family was exceptional, in that its head, an "uncle," was seventy-five years old and had not followed the usual custom of men of his age and resigned his authority to a younger brother or a son. All the names of the family had been given by this uncle instead of, as usual, suggestions having been offered by several of the family at the rice-giving ceremony. The rite of "beginning education" was performed at the age of five years by the family Brahmin, who put the pen in the child's hand and guided him in forming the letters. Although S C Bose was at first slow to learn, he developed a prodigious memory and an extraordinary mathematical capacity In speaking of marriage he says that parents pay a good deal of attention to colour. They know that it is inherited, particularly if it is dark. The standards of beauty are figure, contour of face and colour. Parents may be put to a good deal of expense if a daughter is dark—an interesting commentary in practice on the colour theory of caste

Oyster Breeding Experiments.—Experiments to ascertain the conditions governing the production and settlement of oyster spat have been carried on since 1918 at the Ministry of Agriculture and Fisheries' Shellfish Research Station at Conway, and this year the Ministry's mussel purification tanks at Lympstone were also used for this purpose during the off-season for mussel cleansing. A feeding experiment with ordinary yeast carried on this year met with some success The young oysters were able to swallow the yeast cells, and in one tank so treated at Conway a useful spatfall was secured. At Lympstone a very heavy spatfall was obtained; so many as 150 oysters setting on a tile. Two special features were noted in connexion with the tank where the heaviest spatfall occurred: first, that there was a very large population of small fish (gobies) which were absent from other tanks; and secondly, the presence of a minute vegetable organism. The intestines of the oysters were found to be full of this green material, almost to the exclusion of other organisms. The gobies may have kept the water clear of certain organisms which compete with the young oysters for food. Some hundreds have therefore been transferred to one of the tanks at Conway, and it is hoped that they may breed sufficiently to allow of experiments being carried out next year Cultures of the special vegetable material on which the oysters were observed to feed have been made, and further experiments with this organism will also be carried on next season. Another feature was the rapid growth of the Lympstone oysters, which reached a diameter of 2 inches in less than two months: a rate of growth outside all previous experience The spat has been laid down in the Exe Estuary, and in the Menai Straits; the mortality has been negligible Some of the spat has also been laid down by a large firm of oyster planters at Brightlingsea.

Waxes of Indian Cottons.—A curious fact emerges as the result of a study by Leslie V Lecomber and Maurice E Probert of the waxes of cotton samples from different countries, by the methods which have recently been worked out in the laboratories of the British Cotton Industry Research Association (*Journal of Text Inst*, vol. 16, No. 11, November 1925). Whilst American and Egyptian cottons show no constant differences in the composition and properties of the wax extracted by carbon tetrachloride, which could be regarded as characterising the country of origin, in every case waxes from Indian cottons prove to be characterised by a high saponification value. This is the most outstanding character of the Indian waxes, but they also possess a relatively low melting-point, high acid and iodine values, and contain a low percentage of unsaponifiable material.

Grass Rusts of South America.—J. C. Arthur reports upon the collection of grass rusts made by the late Prof. Holway during extensive journeys in South America during 1919–22, journeys made especially with the view of collecting rust fungi on grasses and on alternative host plants, in the *Proceedings of the American Philosophical Society*, Vol 64, No 2, 1925. This collection forms the basis for a general re-examination of all recorded data as to grass rusts in S. America, with the result that 74 species are listed with notes as to host plants and distribution; five-sixths of these species were represented in the Holway collections

"Mouldy Rot" in Hevea Brasiliensis.—A paper by F. W South and A. Sharples on the spread of this disease in Malaya is of interest as the record of the spread of a fungus parasite, presumably introduced about 1916 in some plantation through plant materials imported into the country, until it is now well established in a large part of the rubber-growing area (Bulletin No. 37 of Dept of Agriculture, Straits Settlements and Federated Malay States). Inoculation experiments seem to establish definitely the identity of the causal fungus as *Sphæronema fimbriatum* (E. and H). One spore form of this fungus, a dark-coloured endospore or macrospore, is very resistant to drying, and as the fungus is a wound parasite, it may spread by this means on the knives of the tappers as they pass from one plantation to another. The disease has now a firm hold and there seems little likelihood of its eradication, but the authors describe experiments, confirmed by extensive trials on a commercial scale, which show that it may be kept under control by painting or spraying antiseptics on to the tapping surface. Particularly good results seem to have been obtained with a proprietary article known as "Agrisol."

Zoological Position of the Arthrodira.—The position of the Arthrodira and Coccosteomorphi among fishes has for long been debated. At one time they were thought to belong to the Dipnoi, but more modern views have brought about their removal from that group without, however, assigning them to any other definite place. Dr. Eric Stensio of Stockholm has just published a most interesting and important paper dealing with the question in vol. 4, No. 4, of the Geological Series of the Field Museum of Natural History (Chicago, October 1925). It appears that a specimen of Macropetalichthys in the collections of the Museum gave promise of showing, after suitable development in the laboratory, something of the structure of the primitive cartilaginous neurocranium It showed eventually much more than this, in that it has enabled Dr. Stensio to describe in detail much of the anatomy of the brain, nerves and course of the blood vessels. These are fully described and figured in the first part of his paper. The author then describes a new genus, *Epipetalichthys wildungensis*, and in a third section gives a general review of the whole group. It comes rather as a surprise to find a list of eleven characters in the primordial neurocranium which are essentially elasmobranch, and in his concluding remarks the author, after pointing out that the Arthrodira are certainly not Crossopterygians, nor Dipnoi, nor Palæoniscids, nor *a fortiori* Actinopterygians, comes to the conclusion that as they are undoubted fishes unrelated to the non-fish Ostracodermi, then they must be elasmobranch in affinities. This view has much to commend it, but necessitates a somewhat drastic re-orientation of our ideas as to the course of evolution in the cartilaginous fishes, in that they must now be considered to have come from ancestors with a covering of true dermal bones which they have secondarily lost. The fact that bone is an exceedingly primitive substance, *e g.* in the ostracoderms, gives some support to the thesis

SOLUTION LAKES IN SWITZERLAND.—In a paper read on December 7 to the Royal Geographical Society on the lakes of Scotland and Switzerland, Prof L. W. Collet directed attention to the numerous basins produced by the solvent action of water on calcareous and dolomitic strata in Switzerland. These lakes are of two kinds, according to whether they occupy a doline or a polye, the latter being the larger, and due to the union of several dolines. Lakes of this nature in the Alps frequently have their floors covered with deposits of impervious material derived from ground moraines of ancient glaciers. This points to the basins not being entirely due to chemical action In fact, Prof. Collet believes that in the majority of cases glacial action has played a part in the process of deepening The glacier has cleaned out and deepened a cavity formed by chemical action, and its ground moraine has completely closed up the fissures in the limestone; thus the existence of a lake has become possible. Thus the lake of Mutten, which was generally considered to be a corrie lake, proves on close examination to be a solution basin with moraine matter on its floor. The Oberstockensee and the Daubensee are cited as other examples of solution basins

PLEISTOCENE CAVE FAUNA OF MALTA.—The annual report of the Valletta Museum for 1924–25 records many interesting additions made by Miss G Caton Thompson to the fauna of Ghar Dalam. The bones were determined in the Geological Department of the British Museum by Miss D. M A. Bate The following represent genera not hitherto recorded from the cave deposits of the Maltese islands: a shrew, *Crocidura*, cf. *leucodon*; a bat, *Rhinolophus*, cf *euryale*, a field mouse, *Apodemus sylvaticus* The following species, recorded from these deposits for the first time, are now, except the owl, either rare visitors or entirely absent from the region: the short-eared owl, *Asio accipitrinus*; the sheldrake, *Tadorna cornuta*; the rook, *Corvus frugilegus*; and, most noteworthy, the carrion crow, *Corvus corone*. Other new records are the thrush, the blackbird, a very small fox, a small carnivore (? wolf). Considering the amount of work previously done at Ghar Dalam, this is a remarkable harvest for one season, and shows the advantage of expert co-operation. The importance of such precise details in working out the geography and climate of the period needs no emphasis.

PORCELAIN CENTRIFUGAL VESSELS IN CHEMICAL ANALYSIS.—In the *Chemiker Zeitung* of November 20 there is an interesting account by Pincussen and Arnstein of the adaptation of the centrifugal method of filtration to chemical analysis in physiological chemical analyses. The rapidity, ease, and cleanliness with which separations can be obtained render this method superior to the older methods of filtration in physiological investigations, since changes which are due to adsorption phenomena can be avoided with much greater certainty. The new vessels are made of porcelain and can therefore be ignited and weighed if necessary. Tests were made of the efficiency of the method by carrying out estimations of sulphuric acid as barium sulphate and of aluminium as alumina. In both cases the error was greater than that obtained in the usual way. On the other hand, the quantities of material weighed were unusually small.

THE ABSORPTION OF HYDROGEN BY PALLADIUM AND BY PALLADIUM SILVER ALLOYS.—The great difference between the atomic weights of palladium and hydrogen makes it impossible to determine directly the position of the hydrogen atoms with respect to those of palladium by means of X-ray spectrograms If, however, the density of saturated palladium, which at 0° C and 760 mm. Hg. absorbs 523 times its volume of hydrogen, or about one hydrogen to two palladium atoms, is calculated on the assumption that the hydrogen atoms replace those of palladium in the lattice, the value obtained is 7·3, while that observed is 10·76. Messrs. F. Kruger and A Sacklowski, in a paper in the *Annalen der Physik* for November, conclude that the hydrogen atoms are distributed between the atoms of the palladium lattice, which is thus expanded considerably. They have investigated electrolytically the absorption of hydrogen and determined the dimensions of the resulting lattices for a number of alloys of palladium and silver. The result is rather remarkable, the lattice dimensions of the hydrogen-free alloys increase according to a linear law as the amount of silver increases, in accordance with Vegard's law, those of the hydrogen-saturated alloys remain practically constant from pure palladium up to about 70 per cent silver, the amount of hydrogen absorbed following a linear law as the amount of silver is increased, and dropping to zero for about 70 per cent of silver in the alloy.

THE PHOTOGRAPHIC ACTION OF H-RAYS FROM PARAFFIN AND ALUMINIUM—The hydrogen nuclei ejected by collisions of α-particles have so far been mainly investigated by the scintillation method and by the Wilson cloud method. Muhlstein in 1922 indicated the possibility of the use of photography for the purpose, and in the *Zeitschrift fur Physik* of October 5, Fraulein M. Blau describes a method, based on that employed by Michl in connexion with α-rays, in which the H-rays produced by the bombardment of a thin sheet of paraffin with α-rays from polonium pass at a rather steep angle through a photographic film, each H-nucleus producing a row of black dots which appear when the plate is developed. Various difficulties had to be overcome owing to the long exposure required, which made it necessary to reduce all photographic action due to β- or γ-rays to a minimum, and it was impossible to obtain results with the longer range α-particles produced by radium C, which give H-rays with a range of nearly 30 cm. and could be expected to give longer rows of black dots than the H-rays due to the α-particles of polonium, the range in air of which is only about 16 cm A comparison experiment in which the paraffin sheet was replaced by a layer of lamp black, containing the same amount of carbon as the paraffin with very little hydrogen, did not show the rows of dots Aluminium foil free from adsorbed gases also gave H-ray tracks in the photographic plate when bombarded with α-rays from polonium, so that it appears that the atoms of this metal can be disintegrated by α-rays of less than 4 cm. range, which agrees with the results of E. A. W. Schmidt, and contradicts those of Rutherford and Chadwick, who found a lower limit of 4 9 cm

The Ignition-point of Gases and its Relation to Volume and Pressure.[1]

AS part of the investigations on the ignition of gases undertaken by the Safety in Mines Research Board, Prof. H. B. Dixon and Mr. J. Harwood have measured the change of volume required to fire various mixtures of methane with air, and of hydrogen with oxygen, when these gas mixtures are suddenly compressed in steel cylinders.

As the compression was carried out originally, according to Prof. Nernst's suggestion, the piston was driven down by a falling weight until it was stopped by the explosion of the gases, the distance within the cylinder traversed by the piston registering the compression. Now the gases do not burst into flame at the moment the ignition-point is reached; an interval of self-heating occurs (varying in length with different gas mixtures) during which the piston will continue to descend—thus indicating a greater compression, and higher temperature, than was really needed to fire the gases. This error was corrected by stopping the piston mechanically by means of a head which was caught by steel collars of the desired thickness placed over the mouth of the cylinder. Later on another source of error was pointed out, namely, the possibility of the self-heating gases pushing up the piston and weight and thus losing heat by doing work at the beginning of the pre-flame period.

Methods have now been adopted which meet these two sources of error. The older apparatus was fitted with three powerful clamps which by means of strong springs should slide over the weight in its lowest position and hold it rigidly down on the piston. In practice it was found that the rebound of the weight when suddenly stopped prevented the certain action of the clamps: but the insertion of a small lead cylinder between the piston head and the weight allowed the weight to continue its fall (after the piston was stopped) for a fraction of a second, during which the clamps had time to make good their hold and keep the weight tight against the flattened-out lead disc.

A new machine has also been designed in which a toggle-joint (as used by Ricardo) is straightened out by a falling weight. This mechanism ensures that the motion of the piston may be stopped at any given point, and also that it may be held firmly in that position if the toggle-joint is kept horizontal. The new machine has a cylinder of twice the diameter of the old, and it is found that, while the rapidly firing mixtures such as electrolytic gas require nearly the same compressions in the two machines, the slower firing mixtures of methane and air show lower ignition-points in the larger cylinder.

To study the effect of differences in initial pressure on the ignition-point of gases—a question raised by the observation of the powerful compression-waves propagated in the firing of the high explosives used in coal-mines—Prof. Dixon, in collaboration with Mr. W. F. Higgins, has modified the concentric tube apparatus, designed some twenty years ago, so as to observe the ignition-point of various gases in air and in oxygen at pressures above and below the atmospheric pressure.

The silica cylinder surrounded by its electric furnace is encased in a strong steel vessel, and is fed from below with compressed air or oxygen—for high-pressure experiments—the excess of air escaping (with the products of combustion) at the top of the vessel. For low pressure trials the air, or oxygen, is allowed to enter below and is drawn off at the top by a motor-driven exhaust-pump, so as to maintain a constant pressure during each experiment. The combustible gas is admitted through the narrow central tube, which opens in the middle of the large cylinder, by turning a tap on the outside of the vessel—the gas passing from the holder through adjustable valves. Observation of the flame is made through a glass window, and the interval between the turning on of the gas and its ignition is timed by means of a pendulum and metronome ticking half-seconds. As the temperature rises, this interval or "lag" becomes shorter in successive experiments, and when it falls to 0·5 sec. (0·6 sec. in the case of methane) the temperature observed is called the rapid ignition-point.

The effect of variations of pressure on methane and on hydrogen was found to be very different. With methane in air, the rapid ignition-points fell regularly as the pressure was increased from 1 to 7 atmospheres, and when the pressure was lowered the ignition-points continued to *rise* so long as the gas would light, although the *rate of rise* fell off as the pressure was reduced from 150 mm. to 100 mm. of mercury. On the other hand, although the ignition-point of hydrogen in air fell regularly as the pressure was increased from 2 to 7 atmospheres, it also fell very sharply as the pressure was reduced from 150 mm. down to 75 mm. of mercury.

The experiments in oxygen confirmed these made in air, except that the rapid ignitions of methane in oxygen showed a maximum temperature at 200 mm. pressure; above or below this pressure, the ignition-point fell. This fall in the ignition-point at very low pressures appears to be a general property of gases: its cause is as yet unexplained.

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[1] Substance of two papers, (1) "On the Firing of Gases by Compression," by Prof. H. B. Dixon and Mr J Harwood, and (2) "On the Ignition-point of Gases at Different Pressures," by Prof H B Dixon and Mr. W. F. Higgins, read before the Manchester Literary and Philosophical Society on Tuesday, November 10

British Marine Biology.

THE Marine Biological Association has now at Plymouth a laboratory in the same class as those at Naples and Woods Hole. It only lacks that cosmopolitan element, which largely makes the charm at Naples. It has its zoological, physiological, and fisheries departments and a research vessel that can visit even deep-sea areas. Its growth, while largely due to the recognition of the importance of basal scientific research work in the elucidation of practical problems by the Development Commissioners, is chiefly owing to the broadness and scientific insight of its Director, Dr. E. J. Allen, this being the main factor in attracting the fifty-six naturalists who occupied its tables in the past year; Dr. Bidder has also been generous and, as treasurer, active in obtaining money for several new buildings.

The journal of the Association (vol. 13, No. 4), by arrangement, includes the work of other British marine laboratories. Prof. Meek leads off with a critical account of legislation on the catching of crabs and lobsters on the east coast of England. The crab sheds its shell in autumn and takes some months to reform and harden its new coat It is poor in quality then, and the fishing is a most destructive one. To protect it the Eastern, North Eastern, and Northumberland fisheries committees have closed the crab fisheries at different times during these months. The author analyses the results in comparative graphs, which show quite a remarkable benefit in the total catch of each district. Northumberland gives particularly striking results, while it is shown that the Scotch coast to the north has gained by migration about a quarter of a million female crabs each year owing to this closure The paper should be read by every legislator for, if it does nothing else, it shows by inference how foolish and wasteful it is, scientifically speaking, to have fisheries in each of our three islands in the hands of different authorities, and coastal fisheries under a series of independent local committees. Each county might just as well manage the railways within its boundaries.

F. S. Russell deals with the diurnal changes in the distribution of the macroplankton. The place sampled was about half way between the Plymouth breakwater and the Eddystone, in 51 m. of water. The date was the full moon on July 15-16, 1924, fair weather. The author clearly hopes that he was beyond the region of local swirls and upward currents, but to convince us of this he should surely have taken serial temperature and pH readings. We should have liked also to know a little more about the weather and particularly the strength of the light. Five series of observations at different depths were taken with a large round stramin cloth net of 2 m. diameter at approximately equal intervals Each haul was 10 minutes A depth recorder was attached, and the depth path of the net at each haul was recorded The organisms caught were counted, and lists are given of those definitely migrating to the surface at night, of those dispersing evenly through the body of water, of those making smaller but yet definite upward migrations, and lastly of those not affected. The young stages of fish are omitted, but are to be recorded in a separate paper. Of isolated facts, 14,000 Tornaria-larvæ caught in the surface haul at midnight is interesting, while the various crustacean larvæ are particularly well done, thanks perhaps to the stimulus of Dr. Lebour. The work is of real importance and clearly must be repeated , we would like it to be done much farther from land and at a season when larvæ are less abundant, so that the whole problem may, to start with, be simplified as much as possible.

C. F. Hickling has been working on the Atlantic slope and there he obtained luminescence in a species of deep-sea fish, *Malacocephalus lævis*, produced by an epithelial invaginated gland opening around the anal papilla and lying in front in the ventral wall of the abdomen ; it is of considerable size and is provided with connective tissue struts and a muscle sheath. The secretion is highly luminous and appears to be always poured out by the dying fish. It goes into solution in water, but constant shaking (? oxidation) is required to maintain its luminosity. It is not due to bacterial action, but to a definite substance which has been termed luciferin. It is suggested that the material may be shot out as ink is by a cuttle-fish, only here a cloud of light, while the fish darts off to escape from danger ; it is also possible that the light may be used to attract food.

Four papers deal with Crustacea. Miss Jorgensen describes the early stages of Nephrops. Dr. Lebour has nearly completed the description of the stages of Nyctiphanes, while working in general on Euphausidæ, a family of considerable importance as being fed on largely by herring. Her knowledge of and insight into crustacean development is clearly an asset of importance to the Laboratory. Dr. Stephenson adds a new species of anemone to the British fauna, this being only the second new form in more than sixty years, a remarkable tribute to the zeal and insight of Gosse, whose beautiful pictures are so well known. We hope E Mary Stephenson will continue and extend her work on the same group wherein she emphasises the fact that the cinclides may be soft spots " which can rupture neatly and without harm to the animal when needed as safety-valves." We always like to know in such work the preservatives employed, and we think important results in the minute anatomy will be attained by employing the methods of Ramon y Cajal's laboratory.

Of other papers we may refer to C. M. Yonge's account of the pH in the gut of Mollusca, wherein he shows that the origin of the general acidity of the entire gut lies in the style which dissolves rapidly in alkaline media, its maintenance being the result of a balance between the rate of its secretion and its dissolution ; the acidity may also be caused by the salivary and digestive glands. H. W. Harvey's paper on oxidation in sea-water is mainly concerned with the actual processes, the action of a catalyst being inhibited by dissolved organic substance ; the paper suggests further researches that may well lead to economic results Finally, a new technique for studying the dissociation of oxyhæmoglobin, described by Pantin and Hogben, will make a wide appeal as it is suitable for class work. The Journal concludes with abstracts of thirteen memoirs, published elsewhere but describing the work done at the Plymouth Laboratory.

J. Stanley Gardiner.

Motor Fuels.

To the layman the subject of motor fuel is symbolical of the entire petroleum industry, and in view of the fact that this commodity is at least a tangible and universal expression of commercial activity, there is perhaps something to be said for the idea Listeners to the Howard Lectures at the Royal Society of Arts, delivered by Prof. J. S. S. Brame and published recently in the Society's journal, would, however, have arrived at very different conclusions concerning not only the scope of the industry, but also the complex subject of motor fuels considered as a whole, and they would have at least been impressed with one fact, namely, the rapid strides recently made in research whereby supplementary fuels to petrol are gradually being made available for general consumption.

In his first lecture the author dealt with petroleum, cracked spirit, casing-head spirit and motor benzole, and his remarks on cracked spirit were of particular interest, as this is still a much-discussed product, both from technical (*e.g* refinement) and economic (utilisation) aspects. Efficiency of plant, loss of initial material, gas and carbon formation, and the commercial possibilities of treating residue-oil, are some of the many problems raised in this connexion, though it is clear that they are now well on the way to adequate solution. Cracked spirit is generally blended with ordinary petrol much as is the case with casing-head spirit, neither products being suitable for direct use with motor cars. Referring to benzole, the author remarked on the increasing importance of absorption processes for extracting this fuel from coal or coke-oven gas , such processes simulate those employed for recovering petrol from natural gas, *i.e.* casing-head spirit, though in the former case silica gel has apparently been successfully utilised as an absorbent.

In his second lecture, Prof. Brame discussed power alcohol, fire-risks with fuels, physical properties, boiling ranges, explosive ranges, and calorific values of various direct and mixed types. Regarding alcohol, he rightly stressed not so much the value of this compound as a fuel, but the problem of its cheap, commercial production, without which its application is impracticable. The third lecture dealt with fuel-air mixtures, composition of fuels and efficiency, current research in the United States, and the interesting subject of "anti-knock" compounds, including the famous lead tetraethyl—the distinctive but poisonous ingredient of the temporarily prohibited ethyl gasoline in America. The intricate problems of mixed fuels such as petrol-benzole, petrol-tetralin, petrol-alcohol, and alcohol-ether, etc., were touched on, the whole syllabus thus forming a most comprehensive review of the subject up to the present time

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University and Educational Intelligence.

CAMBRIDGE.—The election of Prof. J. Barcroft to the chair of physiology did not come as a surprise to those who are acquainted with the Cambridge Physiological School He was elected a fellow of King's in 1899, in which year he won the Walsingham medal; he has held several important physiological posts and was appointed reader in 1919.

Dr. R. G. W. Norrish has been elected to a Junior Fellowship at Emmanuel College; he was recently admitted to the degree of Ph.D. for physico-chemical research.

Early in December the town was visited by numerous candidates for entrance scholarships and exhibitions. It is reported that the numbers offering physics and chemistry are considerably greater than usual, whilst those taking biological subjects have fallen off. This is an unfortunate state of affairs in view of the shortage of high-grade biological students.

EDINBURGH.—The University Court has made the following appointments in the Department of Public Health:—Colonel P. S. Lelean, until recently professor of hygiene in the Royal Army Medical College, to the Bruce and John Usher chair of public health, Dr. William Robertson, Medical Officer of Health of the City of Edinburgh, to be Director of Instruction in Sanitary Administration.

Dr. Archibald Milne, Depute Director of Studies in the Edinburgh Provincial Training College, has been appointed a lecturer in the University to conduct the course on school organisation and administration, and Mr. R. B. Kerr, a lecturer in education in the Training College, to be a lecturer in the University to conduct the course on modern educational systems and problems.

LIVERPOOL—At a meeting of the University Council held on December 15, Associate Professor F J. Teago was appointed to the Robert Rankin chair of electrical machinery. Dr. Teago served his apprenticeship in engineering with Messrs. Charles Parsons and Co., returning to the designs staff of this Company in 1909, after spending three years at Armstrong College, Newcastle-upon-Tyne, where he graduated with the degree of B.Sc. In 1912 he was appointed lecturer in electrical engineering at the University of Liverpool. During the War he occupied important positions in connexion with the design of electrical machinery, and as Assistant General Manager of the Ministry of Munitions Steel Works, Manchester. After the War he was appointed senior lecturer in electrical engineering at the University of Liverpool, and in 1924 the title of associate professor was conferred upon him. In 1924 he was admitted to the degree of D.Sc. (Durham). Dr. Teago has published a number of papers on electrical machinery, three of which have been awarded special premiums by the Institute of Electrical Engineers.

LONDON.—Prof A. V. Hill has, on his appointment by the Royal Society to a Foulerton chair, resigned the Jodrell chair of physiology tenable at University College. He will carry out his research work at University College, and the Senate has resolved that he shall continue to hold the title of "Professor of Physiology in the University of London" in respect of the functions to be discharged by him at that College.

The following doctorates have been conferred:—*D.Sc.* (*Embryology*), Mr. A. S. Rau (University College) for a thesis entitled "Contributions to our Knowledge of the Structure of the Placenta of Mustelidæ, Ursidæ and Sciuridæ"; *D.Sc.* (*Physics*), Mr. W. B Haines (University College and the Rothamsted Experimental Station) for a thesis entitled "Studies in the Physical Properties of Soils"; *D Sc.* (*Metallurgy*), Miss Constance F. Elam (Imperial College—Royal School of Mines) for a thesis entitled "(1) Tensile Tests of Crystals of an Aluminium-Zinc Alloy; (2) The Orientations of Crystals in Metal Test-pieces subjected to small Strains followed by Heat-treatment."

THE University College of the South-West of England, formerly known as University College, Exeter, directs attention in its report for 1924–25 to the harmonious development (justifying its change of name) of its scheme for co-operation with the Technical School, Plymouth. With effect from the beginning of the current session, the more technical part of the School of Pharmacy has been transferred to Plymouth, while the pure science part of the curriculum continues to be provided at Exeter as well as at Plymouth. The Department of Law also provides courses at Plymouth, and a project is on foot for establishing a School of Commerce there. The total number of full-time students has increased from 313 to 332, the increase of science degree students alone being from 67 to 87, and of pharmacy diploma students from 10 to 18 The number of degree students has more than doubled in the last four years.

STATISTICS of State Universities and State Colleges for the year 1923–24 are published in Bulletin, 1925, No. 12 of the United States Bureau of Education. Similar annual returns have been published by the Bureau for the past sixteen years, but in this bulletin appears for the first time a tabular statement of tuition and other fixed annual charges payable by students. The subject is one to which much attention has been directed of late. In the institutions, 106 in number, represented in the returns, the total student enrolment, excluding the summer school, was men 148,230, and women 77,567, and the student fees paid, excluding board and room rent, amounted to sixteen million dollars. There is very great diversity of practice in regard to the fixed charges which students are called upon to pay in these state universities and colleges, the amounts varying, in arts and sciences, for tuition and other fixed annual charges, excluding laboratory fees, from nine dollars in the University of Oklahoma to 314 dollars in Cornell University. The table includes figures for medicine, dentistry, law, and pharmacy as well as arts and sciences; in almost all instances the rates for other courses of study such as engineering and agriculture are the same as for arts and sciences. The highest professional school tuition charges are 500 dollars per annum for the Medical School of the University of California. Many institutions at which tuition is nominally free impose "incidental" and "registration" charges, generally small but sometimes considerable, *e.g.* Pennsylvania State College, 100 dollars.

Contemporary Birthdays.

January 1, 1855. Sir Charles L Morgan, Past Pres. Inst.C.E.

January 5, 1846. Sir John Arrow Kempe, K.C.B.

January 8, 1845. Rt Hon. Sir Herbert E. Maxwell, Bart., F.R.S.

January 8, 1856. M le Prof. Henri Lecomte, Natural History Museum, Paris.

January 8, 1868. Sir Frank W. Dyson, F.R.S.

Born at Edinburgh, Sir Herbert Maxwell was educated at Eton and Christ Church, Oxford. As naturalist, antiquary, and worker in the public service, Sir Herbert's many-sided activities have had ample play on both sides of the Border. An ardent chronicler of Scottish history, he was president of the Society of Antiquaries of Scotland, 1900-13, and a lecturer in the University of Glasgow during that period. A recognised authority on Scottish historical monuments, he was Rhind lecturer in archæology, University of Edinburgh, 1893-1911 Sir Herbert was chairman of the Royal Commission on Tuberculosis, 1897-98, afterwards representative of H M. Government at the Berlin Congress on the Prevention of Tuberculosis. Many papers in the issues of the Scottish Natural History Society on the habits of animals and birds proceed from his facile pen. Fisherman and botanist, he has published "Salmon and Sea-trout" (1899), "Fishing at Home and Abroad" (1914), "Trees, a Woodland Notebook" (1914), "Flowers, a Garden Notebook" (1923). His "Memories of the Months" (1897) has gone through many editions. In August last Sir Herbert was appointed by the Crown chairman of the board of trustees of the newly constituted National Library of Scotland, arising from the transfer of the great library of the Faculty of Advocates as a nucleus.

Prof. Lecomte, an Officer of the Legion of Honour, is one of the two professors of botany in the Natural History Museum, Paris He was elected a foreign member of the Linnean Society in 1916, the following year becoming a member of the Paris Academy of Sciences Professor at the Lycée St Louis, 1884-1903, he joined the museum staff in 1906. Founder and first editor of the *Revue des cultures coloniales* (1897), Prof. Lecomte is author of various important works, notably, "Les Textiles végétaux et leur examen micro-chimique" (1892), and "Le Coton en Égypte" (1904).

Sir Frank Dyson, born at Ashby, was educated at Bradford Grammar School, proceeding thence to Trinity College, Cambridge, graduating second wrangler. He was also Smith's prizeman. Chief Assistant at the Royal Observatory, Greenwich, 1894-1905; he was next appointed Astronomer-Royal, Scotland, returning to Greenwich in 1910 to take up the post of Astronomer-Royal. Sir Frank was awarded a Royal medal by the Royal Society in 1921. It was recorded that among many important contributions to astronomy he had devoted special attention to investigations of the movements and distances of the stars, and of the bearing of these upon the structure of the stellar universe. He had been conspicuously successful in obtaining records of the spectrum of the corona and chromosphere during eclipses of the sun. Sir Frank is a corresponding member of the Academy of Sciences, Paris, and a foreign member of the Reale Accademia Nazionale dei Lincei, Rome.

Societies and Academies.

London.

Royal Meteorological Society, November 16—I D. **Margary**: The Marsham phenological record in Norfolk, 1736–1925, and some others. A remarkable phenological record kept by five generations of one family at Hevingham near Norwich is presented. The observations include the dates of leafing of 13 common trees, flowering of snowdrop, hawthorn, etc., and the movements of 8 migrant and other birds. The mean date for a group of seven of the plant events covering the period January-May has been worked out for each year. The annual variations are closely related to temperature and show a very definite periodicity, averaging twelve years between unusually backward springs or early springs. Recent extreme years are: early, 1912, 1921; late, 1908, 1917. The intervals have recently been shorter than the average. Comparing the plant dates in the eighteenth and twentieth centuries (taking averages for the thirty-five year periods 1751–85 and 1891–1925) of the 16 plants, 10 were earlier in the recent period, 3 were unchanged, and 3 later, possibly an indication of an earlier tendency in recent springs. Migrant birds seem independent of these conditions. The swallow's date of arrival is definitely getting later (the average for the thirty-five years 1891–1925 being eight days later than for 1751–85), in contrast to that of the cuckoo, which has on the average kept a constant date throughout the period.—C. D **Stewart**: Experiments in the shielding of rain gauges The chief difficulty met with in the measurement of rainfall is the effect of wind in decreasing the catch of a gauge owing to the eddies set up by its projecting parts At Valencia Observatory it has been found that protection is afforded in varying degrees by buildings, the Nipher shield and pits.—Harold **Jeffreys**: On the dynamics of geostrophic winds All problems of the motions of the atmosphere produced by temperature changes of large horizontal extent can be reduced to closely related problems of tides in an ocean of uniform depth, and, in the absence of friction, they can in general be solved by known methods. The theory is applied to the annual variation of pressure in Central Asia, and gives fair quantitative agreement. When applied to the general circulation, however, it gives easterly winds everywhere. Friction would considerably alter this result, indeed a steady circulation is impossible when friction is present. The only dynamically admissible types of motion with friction involve westerly circulations around the poles and systems of cyclones the height of which is comparable with that of the tropopause.

Geological Society, December 2.—R. D. **Oldham**: The depth of origin of earthquakes. Methods of determining the depth of origin of an earthquake, dependent on observations of the time of occurrence, demand records of a degree of precision, and in numbers, which are seldom available. The same objection applies to the Dutton method, based on variation in the intensity of shock; but the method is capable of a simplification which will make it applicable to any case where the area affected by the sensible shock, and the maximum degree of violence attained, can be determined. The Dutton method is sound in principle, but two important errors have been introduced in the application Acceleration has been taken as the measure of intensity, whereas the formula demands that the product of maximum acceleration and amplitude of displacement should be used, and the effect of absorption of energy in transmission has been treated as negligible. The errors so introduced are, however, opposite in sign and about equal in amount, so the depth obtained is approximately correct. The simplified method is applied to the discussion of the Italian record for the years 1897–1910, comprising 5605 distinct shocks: it is found that more than 90 per cent. of these originated at depths of less than 10 km., and mostly round about 5 km.; while only 1 per cent. originated at depths exceeding 30 km. This is in strong contrast with the depths of origin of the distant records, which seem to vary from 50 km., in a few cases, to, in most cases, 100 km. or more. From this it is concluded that where distant records accompany a destructive earthquake, the disturbance has a two-fold origin, the episeism, or surface-shock, by which the damage is directly caused, being a secondary result of the bathyseism, which is the origin of the distant record. The great number of local shocks are purely episeisms, without any recognisable bathyseism.

Linnean Society, December 17.—H. Graham **Cannon**: On the feeding mechanism of a freshwater ostracod, *Pionocypris vidua* (O. F. Müll.). The shell-cavity is incompletely divided into an anterior and a posterior chamber by the large "oral mass" suspended from the more dorsal parts of the valves. The mouth-entrance is on a level with the ventral edges of the shell. A stream of water is caused to pass antero-posteriorly through the shell by three vibratory plates. The organism is essentially a crawling form, and feeds on anything that it kicks up in its wanderings. The disturbed particles are sucked in by the water stream and eventually are transferred to the œsophagus by a pair of "food rakes" that occur in the posterior wall of the oral cavity.—R. R. **Gates**: The vegetation of the Amazon basin. The whole of the Lower and Middle Amazon basin, from the Atlantic to the Andes, lies within a few degrees of the Equator and represents the greatest area of forest in the world. Practically the whole region is clothed with luxuriant tropical rain-forest. The Amazon surpasses any other river in its drainage-area and in the volume of water discharged, the main channel being 40 to 60 fathoms deep up to Manaos (1000 miles). At high river, in June, the water-level is in many places more than 50 feet above its level at the end of the "dry" season. As the river rises, thousands of square miles of forest-country are inundated. This is known as *igapo*, and the annual flooding has striking effects on the vegetation. Among floating plants, several species of Eichhornia are common; and *Victoria regia* spreads its leaves in sheltered lagoons. Another characteristic plant along the river is a gigantic "pampas" grass (*Gynerium sagittatum*), called *flexa* in Portuguese, because the upper part of the stalk is used to make arrows for shooting turtles. Small fine-leaved bamboos of many species occur in some places. The two most numerous families in the forest are the Cæsalpinioideæ and the palms.

CAMBRIDGE.

Philosophical Society, December 7.—R. W. **Ditchburn**: The quenching of resonance radiation and the breadths of spectral lines. The virtual radiation theory put forward by Slater and others is incompatible with one or other of the sets of experimental results by Stuart, Fuchtbauer, Joos, and Dinkelacker.—G. H. **Briggs**: A photographic method of determining the mobility of recoil atoms. The method is a modification of Zeleny's, using parallel plates. The source of recoil atoms was a narrow line of mesothorium bromide on platinum on the lower plate perpendicular to the direction of the air stream. Such a source gives thorium X, thorium A, and thorium B by recoil. These atoms are carried across by the electric field to the top plate and give two bands of activity, one when there is no air current and a displaced band when there is a steady flow of air between the plates. The distribution of activity on the top plate was found by exposing it directly to a photographic plate and measuring the bands obtained with a microphotometer. No detectable difference in the mobilities of thorium X, A, and B was found, but there appeared to be a continuous distribution of mobilities from 1·24 to 1·84 with a maximum at 1·56 cm. per sec.—R. L. **Alston**: (1) Some developments in the X-ray analysis of single crystals. Müller's method of single-crystal analysis has been extended to iron crystals, for which [110] axes only are conveniently determined. For a given angle of reflexion, the axes determined by this method at a given point on the surface must lie within a limited region, if neither the incident nor the reflected beam is to be obstructed by the body of the crystal. For a plane surface the limits of this region have been calculated and plotted in diagrams for several reflexion angles. A method of analysis making use of reflexions from the continuous spectrum has also been developed. (2) The distortion of large aluminium crystals at crystal boundaries. In a test-piece composed of several large aluminium crystals, the distortion under a tensile load is less near the crystal boundaries than in the body of the crystal. X-ray analyses show that the distortion becomes progressively less as the boundary is approached, from a distance of two or three mm., but is of the same character as that in the body of the crystal, *i.e.* a shear on the same plane and in the same direction. The boundaries are more rigid than the crystals and one crystal does not slide over another.—P. A. M. **Dirac**: The adiabatic hypothesis for magnetic fields. A dynamical system undergoing an adiabatic change does not necessarily satisfy Hamilton's equations when it involves forces depending on the velocities. For a system in an adiabatically varying magnetic field, the electric forces which necessarily accompany the varying magnetic field just compensate for the preceding effect; thus the usual proof of the adiabatic invariance of the quantum integrals, based on the assumption of Hamilton's equations, is valid.—E. L. **Ince**: (1) Periodic solutions of a linear differential equation of the second order with periodic coefficients. (2) The second solution of the Mathieu equation.—G. **Timms**: The equianharmonic and harmonic envelopes of a quadrinodal cubic surface.—M. J. M. **Hill**: On the substitution of Wallis's postulate of similarity for Euclid's postulate of parallels. Addendum.—C. G. F. **James**: On a family of constructs in higher space.

EDINBURGH.

Royal Society, December 7.—W. J. M. **Menzies**: Salmon (*Salmo salar*) of the River Moisie (E. Canada). These salmon are very similar in their habits of life to salmon in Great Britain, and their scales are a good indication of their age and history. The average age of the smolts at migration is rather higher than the average age of the salmon in the northern rivers of Scotland, though they are not quite so old as the smolts in many of the Norwegian rivers. The percentage of fish which have spawned on one or more occasions is also higher than in Britain, and one salmon was found which had spawned no less than four times. The majority of fish belong to the large spring or three winters in sea class and their average weight is therefore considerable.—Fred J. **Symon**: The diffusion of salt vapours in a bunsen flame. It has been previously shown by Prof H. A. Wilson that for a bead of salt evaporating in a bunsen flame the coefficient of diffusion of the metallic vapour in the flame may be determined if the positions of two points are known where the concentration of the vapour is the same. Points of equal concentration can be found by an electrical method and the values obtained for the coefficient agree with the values previously got by H. A Wilson.—**William Cooper**: Note on copper tinted flame caps: an investigation into the colorations obtained in examining different inflammable gas mixtures, using a copper loop in the testing flame, and carbon tetrachloride in the fuel.—F A. E. **Crew**: Prenatal death in the pig and its effect upon the sex-ratio. The secondary sex-ratio in the pig is equality; the primary, as revealed by an examination of fœtuses, is not less than 150 male: 100 female. The very considerable prenatal mortality bears more severely upon the male throughout the pregnancy—E. L. **Ince**. Researches into the characteristic numbers of the Mathieu equation. This paper is a first step towards the efficient tabulation of the Mathieu functions The author gives a method by which the characteristic numbers may be evaluated for reasonable values of the parameter q. A table of the five lowest characteristic numbers is given from $q=0$ to $q=1$—T. M. **MacRobert**: The addition theorem for the Legendre function of the second kind. The addition theorem for the function $Q_n(x)$, which was established by K. Neumann for positive integral values of the degree n, is proved to be still valid when n is not an integer.—Sir Thomas **Muir**: The theory of continuants from 1900 to 1920.

PARIS.

Academy of Sciences, November 30.—L. **Lecornu**: The problem of refraction.—L. E. **Dickson**: New algebra of division.—H. Kamerlingh **Onnes**, Jean **Becquerel**, and W. J. de **Haas**: The magnetic rotatory power of some paramagnetic minerals at very low temperatures. The magnetic rotatory power of tysonite has been measured at temperatures ranging down to the boiling-point of liquid helium. From the figures obtained it would appear that the susceptibility of tysonite follows Curie's law, with a small correction Parisite and bastnæsite have also a considerable magnetic rotatory power, although less than that of tysonite. The variations with temperature follow an analogous law—C. **Sauvageau**: The localisation of bromine in an alga (*Antithamnionella sarniensis*). The author has recently demonstrated the presence of free iodine in two algæ, especially in certain organs to which the name of *ioduques* has been given. Similar cells have now been found in *A. sarniensis*, for which the name of *bromuque* is suggested, since they appear to contain bromine instead of iodine As the reagent for bromine, a solution of fluorescene is used; this is converted into eosin by the substance present in the cells. The bromine must either be free, or present in a very loose combination—E. F. **Collingwood**: A theorem of Lindelof.—J. **Sudria**: The determination of the projected displacement of a point of a body at the centre filament.—Const. **Parvulesco**: The conditions of equilibrium of a stellar cloud isolated and deprived of rotation.—G. van **Lerberghe**: The specific affinity as a function of the fugacities.—Marcel **Peschard**: Some relations between artificial ferro-nickels and a nickel iron of meteoric origin. A study of the Chinautla meteorite (1902) The measurements showed that the meteorite was in physico-chemical equilibrium whilst the artificial ferro-nickel was in a metastable state—Mme. S. **Lattès** and Georges **Fournier**. The absorption of the β-rays by matter. It has been shown that for he primary β-rays from radium E, the coefficient of absorption is a linear function of the atomic number. It is now shown that the absorption of the secondary β-rays produced by the primary γ-rays of radium rigorously follows the same law—Jean **Thibaud**: The structure of the nucleus of the radioactive atoms and the emission of spectra of the γ-rays.—C. **Matignon** and Mlle. G. **Marchal**. The thermochemistry of glucinum—Louis Jacques **Simon**: Viscosity and chemical analogy with respect to the viscosity of the metallic acetates in aqueous solution.—Paul **Hænni**: Boron in aluminium and aluminium alloys A study of the changes in the mechanical properties of aluminium and some aluminium alloys produced by the addition of varying proportions of boron—Raymond **Charonnat**. The complex combinations of the ruthenium chlorides.—R **Mellet** and M A **Bischoff**: The application of the phenomena of dyeing to the revivification of printed or written matter removed by chemical treatment In the case of an altered cheque, in which the original writing had been removed by chemical reagents, immersion in solutions of fluorescent substances (such as eosin), and subsequent examination by filtered ultra-violet light, brought out the original writing.—R **Gaubert**: The identity of fibrous limonite with göthite. The facts described prove that fibrous limonites are merely impure göthite.—P. **Russo**. Tectonic and palæontological notes on the region of Bab Moroudj.—Émile **Belot**: The dynamical and isostatic causes of the dissymmetries of the hemispheres of the earth and moon—P. **Lejay**: Storm perturbations of the electric field and their propagation to great distances.—G. **Delépine**: The Goniatite zones of the upper Dinantian and of the Chokier layer in Belgium.—Louis **Emberger** The reversion of the plasts in plants The most important phenomenon in the reversion of the plasts is the subdivision of the substratum, comparable with a sort of pulverisation of the mitochondrial substance, after the resorption of the products of elaboration (starch, pigments). The plasts, after reversion, keep their biological individuality even when they are entirely in the state of mitochondria.—Jacques **Pellegrin**: The reptiles and batrachians of the Grand and Middle Atlas.—L. **Mercier** and J **Villeneuve**: Contribution to the study of the anatomy of the head of the Diptera (*Calliphora erythrocephala*). The ptilin and ptilino-pharyngeal muscle.—J. **Glaja** and X. **Chahovitch**: The maximum metabolism and the suprarenal capsules. From experiments involving partial and total ablation of the suprarenal capsules of the rat, it would appear that these capsules play an important part, perhaps even the essential part, in the accommodation of thermo-genesis—Max and Michel **Polonovski**. A series of alkaloid derivatives with attenuated toxic power. In an earlier communication it has been shown that geneserine from the Calabar bean, in which the basic tertiary nitrogen of eserine is blocked by oxygen, while possessing the physiological and therapeutic properties of eserine, is only slightly poisonous An attempt has now been made to see if blocking the nitrogen atom with oxygen produces the same effect in other alkaloids, these compounds being named by analogy genatropine, genostrychnine, etc. It has been found that in the case of the nitrogen-oxides of atropine, hyoscyamine, scopolamine, and strychnine, the specific physiological action of the original alkaloid is preserved but that the toxic action is greatly reduced.—C. **Gessard**, E. **Fernbach**, and G. **Ruller**: Morphological modifications of the tubercle bacillus in a culture associated with a pyocyanic bacillus (melanogen variety).—— **Cluzet** and — **Chevalier**. Unidirectional high frequency current; physiological effects. By interposing an electronic valve in the circuit of a medical high frequency installation, a unidirectional current of the same frequency is obtained. A description of the physiological effects produced by these rectified high frequency currents is given.

SYDNEY.

Linnean Society of New South Wales, October 28.—W. W. Froggatt: Notes on Australian Coccidæ with descriptions of new species. Descriptions of three species of Lecanium as new. They were found in cavities in branches or trunks of forest trees. As the inner surfaces of these cavities are hard, dry, and sapless, the larvæ apparently develop into adult females with very little moisture or apparent food.—May M. Williams: The anatomy of *Lindsaya linearis* and *L. microphylla*. The apices of the rhizome, leaf, and root of both forms are of the normal leptosporangiate type. The petiolar bundle forms a single strand containing three protoxylem groups, two of which are endarch in position; the third (median) group in *Lindsaya linearis* is exarch, but in *Lindsaya microphylla* occupies various positions at different levels of the petiole, these positions varying from exarch to endarch.—A. M. Lea: Descriptions of new species of Australian Coleoptera. Pt. xviii.—W. F. Blakely: Contributions to our knowledge of the flora of New South Wales. Four new species, one each of the genera Grevillea, Tetratheca, Astrotricha, and Olearia.—R. J. Tillyard: Two new species of silky lacewings (Fam. Psychopsidæ, Order Neuroptera Planipennia) from Australia. These bring the total of species described from Australia to twelve. One is from central Queensland and is nearest to *Psychopsis gracilis*, the other is from Roebourne, W.A.—P. D. F. Murray: A note on an unusual type of secreting epithelium in the Wolffian duct of the dog-fish (*Scylliorhinus canicula*). The epithelium is one or two cells thick, the cells being of low columnar form, and was noticed both in the vas deferens and in the vesiculum seminalis.

Diary of Societies.

SATURDAY, JANUARY 2.

Royal Institution of Great Britain, at 3.—Sir William Bragg: Old Trades and New Knowledge: (3) The Trade of the Weaver.

MONDAY, JANUARY 4.

Royal Geographical Society (at Æolian Hall), at 3.30.—Mrs. Julia Henshaw: The Mountain Peaks of Canada (Christmas Lecture to Young People).

Child-Study Society (at University College), at 5.—W. S. Rowntree: The Childhood of the Race.

Royal Institute of British Architects, at 8.—Sir C. Nicholson and Sir Francis Fox: Lincoln Cathedral.

Aristotelian Society (at University of London Club), at 8.—C. A. Richardson: Paper.

TUESDAY, JANUARY 5.

Royal Institution of Great Britain, at 3.—Sir William Bragg: Old Trades and New Knowledge: (4) The Trade of the Dyer.

Optical Society and Physical Society of London (at Imperial College of Science and Technology), Afternoon and Evening.—Exhibition of Electrical, Optical, and other Physical Apparatus.

Institution of Automobile Engineers (at Royal Society of Arts), at 7.

Institution of Electrical Engineers (North-Western Centre) (at Engineers' Club, 17 Albert Square, Manchester), at 7.

Institute of Metals (Birmingham Section) (at Chamber of Commerce, Birmingham), at 7.—O. F. Hudson: The Influence of Work and Annealing on Brass.

Royal Photographic Society of Great Britain, at 7.—F. C. Tilney: Form and Content in Pictorial Art.

Hull Chemical and Engineering Society (at Grey Street, Hull), at 7.45.—A. Grounds: Fuel Economy in Steam Plants.

Röntgen Society (at British Institute of Radiology), at 8.15.—Dr. G. W. C. Kaye: (a) A Combined X-ray Tube and Vacuum Pump Unit; (b) The Industrial Uses of X-rays.—The Present Position.—A. F. Dufton: The Measurement of Radium during Radioactive Growth.

Science Masters' Association (Annual Meeting) (at Household and Social Science Department, King's College for Women), at 8.15.—The Bishop of Birmingham: Presidential Address.

WEDNESDAY, JANUARY 6.

Science Masters' Association (Annual Meeting) (at Household and Social Science Department, King's College for Women), at 10.45 A.M.—Dr. T. Slater Price: The Sensitivity of the Photographic Plate (Lecture).—Prof. Leonard Hill: Sunshine, Open Air and Health (Lecture).—At 12.—W. D. Eggar, C. H. Latter, and others: Discussion on Science and Citizenship.—A. M. Weaver, H. H. Duckworth, and others: Discussion on Laboratory Assistants and Laboratory Management. School Exhibitions.—At 5.15 and 6.—Prof. B. J. Collingwood: Demonstration of the Use of Specially Designed Electronic Models for the Representation of Chemical Actions and Electrolytic Phenomena.—At 8.15.—(Lecture-demonstration.) Arranged by Dr. C. S. Myers and F. M. Earle: Methods of Experimental Psychology.—(Demonstrations of Vocation Tests.) Miss W. Spielman: Vocational Selection.—Vocational Guidance:—Miss Stott: Intelligence Tests; Miss Roberts: Manual Ability Tests; A. Macrae: Mechanical Tests; F. M. Earle and Miss Blackett: Special Tests, Job Analyses and Rating Scales.

Optical Society and Physical Society of London (at Imperial College of Science and Technology), Afternoon and Evening.—Exhibition of Electrical, Optical, and other Physical Apparatus.

Royal Society of Arts, at 3.—Prof. H. E. Armstrong: Alice in Wonderland, at the Breakfast Table (Mann Juvenile Lectures) (1).

Geological Society of London, at 5.30.—W. N. Edwards: Fossil Plants from the Nubian Sandstone of Eastern Darfur.—V. G. Glenday and Dr. J. Parkinson: The Geology of the Suk Hills (Kenya Colony).

Institution of Electrical Engineers (Wireless Section), at 6.—Lt.-Col. K. E. Edgeworth: Frequency Variations in Thermionic Generators.

Institution of Heating and Ventilating Engineers (at Caxton Hall, Westminster), at 7.—J. R. Preston: Pump Circulation.

THURSDAY, JANUARY 7.

Geographical Association (Annual Meetings) (at London School of Economics), at 9.30 A.M.—Opening of Publishers' Exhibition and Short Address.—At 11.15.—The Hon. W. G. A. Ormsby Gore: The Economic Geography of the British Empire (Presidential Address).—At 5.—Prof. J. L. Myres: Wayside Geography (Lecture).—At 8.—Private Meeting of University Teachers of Geography. Mrs. Ormsby and others: Discussion on The Compatibility of the Training of the Geographer with the Acquisition of a University Degree in Geography.

Science Masters' Association (Annual Meeting) (at Household and Social Science Department, King's College for Women), at 11 A.M.—D. J. Berridge, E. Nightingale, E. G. Laws, and others: General Discussion: School Science Examinations.

Royal Institution of Great Britain, at 3.—Old Trades and New Knowledge: (5) The Trade of the Potter.

Optical Society and Physical Society of London (at Imperial College of Science and Technology).—Afternoon and Evening.—Exhibition of Electrical, Optical, and other Physical Apparatus.

Institution of Electrical Engineers, at 6.—Capt. P. P. Eckersley: Past, Present, and Future Developments in Wireless Telephony.

Society of Chemical Industry (Manchester Section) (at 16 St. Mary's Parsonage), at 7.—Short Papers.

Society of Chemical Industry (Bristol Section) (at Bristol University), at 7.30.—S. Robson: The Contact Process for Sulphuric Acid.

Institute of Metals (London Section) (at 85 The Minories), at 7.30.—H. J. Gough and D. Hanson: The Fatigue of Metals: a General Survey and an Account of some Recent Work. Pt. I.

Institution of Sanitary Engineers (at Caxton Hall), at 7.30.—Presidential Address.

Institution of Structural Engineers, at 7.30.—J. T. Jacques: The Manufacture and Strength of Brickwork.

FRIDAY, JANUARY 8.

Geographical Association (Annual Meetings) (at London School of Economics), at 9.30 A.M.—Exhibition.—At 10 A.M.—A. G. Ogilvie: South America and Africa as Fields for Geographical Research (Lecture).—At 11.15.—Sir John Russell: Cotton and the Nile (Lecture).—At 2.15.—Sir Halford Mackinder: The Teaching of Geography (Lecture).—At 3.30.—Dr. Vaughan Cornish: The Rhythmic Flow of a River (Lecture).

Royal Geographical Society (at Æolian Hall), at 3.30.—A. F. R. Wollaston: A Naturalist's Journey to Ruwenzori (Christmas Lecture to Young People).

Royal Astronomical Society, at 5.—*Paper received*:—J. G. Hagen: W. Herschel, Discoverer of Dark Cosmic Clouds.

Malacological Society of London (at Linnean Society), at 6.

Institution of Mechanical Engineers, at 6.—Third Report of the Marine Oil-Engine Trials Committee.

Royal Photographic Society of Great Britain, at 7.—Mrs. J. Henshaw: Camping in the Canadian Rockies (Lecture).

Junior Institution of Engineers, at 7.30.—A. J. Simpson: Notes on Salesmanship.

North-East Coast Institution of Engineers and Shipbuilders (at Newcastle-upon-Tyne), at 7.30.—W. Pollock: Star Contra Propeller.

Geologists' Association (at University College), at 7.30.

Royal Technical College, Glasgow, Civil Engineering Society, at 7.30.—G. Fairbairn: Some Applications of Cementation to Engineering Works.—J. W. Mearns: Experiences in British Guiana.

Society of Chemical Industry (Chemical Engineering Group) (at Chemical Society), at 8.—A. E. Knowles: The Manufacture of Hydrogen suitable for the Hydrogenation of Oils.—Dr. A. C. Thaysen: The Production of Hydrogen by Micro-organisms.

Royal Society of Medicine (Ophthalmology and Laryngology Sections), at 8.30.—Discussion on Inflammation of the Nasal Sinuses in its Relation to Optic Neuritis.

SATURDAY, JANUARY 9.

Geographical Association (Annual Meetings) (at London School of Economics), at 9.30 A.M.—Exhibition.—At 10.—Prof. P. M. Roxby: The Concept of Natural Regions in the Teaching of Geography, with Special Illustrations from China.—At 11.15.—Discussions held concurrently in separate rooms:—C. G. Beasley and others: The Place of Geology in a Two Period a Week Geography Course.—C. D. Forde and others: Detail in Geography Lessons.—Major A. G. Church and others: Geography in Relation to other School Subjects.—Miss R. M. Fleming and others: Geography for the Younger Children in Primary Schools.

Royal Institution of Great Britain, at 3.—Sir William Bragg: Old Trades and New Knowledge: (6) The Trade of the Miner.

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Statistics in Administration.

A LARGE amount of work has been done in developing statistical methods on the scientific side, and it is natural for any one interested in science to hope that all this work may be utilised in commerce and industry. There are signs that such a movement has started, and it would be unfortunate indeed if those responsible in practical affairs fail to take advantage of the improved statistical machinery now available.

There are, admittedly, many difficulties in the way of introducing into any business a new type of investigation, and, even when these are overcome, we are aware that much of the statistical work of business is, and must be, mere tabulation—a dull form of accountancy that ends before the interesting process of analysis, investigation, and interpretation begins. In some of this tabulation, the form in which results have to appear is dictated by Act of Parliament, so we are deprived of using any ingenuity in arranging the figures. This is always regrettable to any one really caring about the subject, for though tabulation at its worst is about as dull as anything can be, it is made by skilful hands the first and by no means the least important element in any complete statistical investigation. Here we reach the beginning of things: the statistician may have specific problems to solve and may be able to start the preliminary work as he likes; he can then feel most happy about his results, and he has the best chance of making those incidental discoveries which are interesting in all scientific work and often very valuable in statistical work in business. But he does not often have such a chance: over and over again some sort of statistical tabulation has been going on, and expense or delay puts rearrangement outside the realm of practical politics. The problem is then: " What is the best we can make of figures in the particular form ? "

Here, and in other cases, the trained man has the best chance of drawing useful conclusions, but it would be wrong to expect any statistician unfamiliar with a particular business to find out as much from statistics as would be possible if he knew a business well: ignorance of a business may lead to mistakes which experience instinctively avoids. Here possibly we see the fear, so far as it exists, of the professional statistician: and in a sense some fear, or at any rate some hesitancy, is right; but the answer is not that the trained man should be avoided because he may make a mistake when called in to examine statistics of a business with which he is unfamiliar, but that in any business where statistical work is essential, a trained man should be on the staff. In some businesses trained men are employed as a matter of course: no respectable life assurance company would, for example, dream of conducting its business without having an actuary to examine and advise.

One part of statistical work often wanted in business is called by the fairly descriptive name of "cost accounting." In its simplest form it is merely the setting out of the cost of production of an article, but in many cases the problem is of much complexity, and in some ways it involves methods and principles like those adopted by an actuary in ascertaining the periodic payment necessary to meet a more or less complicated benefit. It seems, from this point of view, a little strange that this work should have fallen to the accountant rather than to the actuary, but both professions are trained to some extent in statistical work, and accountants, being auditors or on the staff for other purposes, are more readily available and have, at any rate, a superficial knowledge of the particular business.

It happens occasionally in practical work that a new process or a change in procedure or manufacture is suggested, and it is thought worth while to make a trial of the process. Any single trial may be a failure and yet the process may be an improvement on the old: the proportion of failures may be less. A success may depend on the combination of a number of causes. A trial may, however, be an expensive matter. The trained statistician who has studied those awkward problems of small samples will alone be able to read the answer correctly and to judge properly from a few experiments whether the proposed reform is worthy of adoption. Much of the statistical work done in biology at Rothamsted under Mr. R. A. Fisher is necessarily based on small samples, and the original work by "Student" in *Biometrika* seems to indicate a field of work on small samples in a practical business.

Generally speaking, however, the statistical work we have in mind would be of wider scope. It is only possible to judge of the success of each part of a business by investigation, and in many instances a study of a simple kind can tell a good deal, but if there is interlocking, if incidental profits are thrown up or if an apparent loss can be afforded in one part of the business because it is always associated with a large profit elsewhere, then the work may assume a troublesome complexity. We should anticipate that a well-trained practical statistician with a "roving commission" over all the figures produced in a business would save his salary over and over again.

We may now consider what training is available for the more highly skilled statistical work. Probably the most advanced school is that of University College, London, where Prof. Karl Pearson and his assistants and pupils have done so much original research both theoretical and practical. Then there are some other colleges of the University of London teaching the subject, sometimes, however, from a rather special point of view, *e.g.* at the London School of Economics. There are also opportunities for study at Cambridge and elsewhere, and there is a comparatively newly constituted school under Prof. E. T. Whittaker at the University of Edinburgh. In the United States the subject is taught fairly generally in some form or another, but, judging from the books published, it is sometimes only dealt with superficially. Apart from the universities, probably the best places to learn the subject—and for certain businesses the schools, if they can be so called, are probably as good as any—are the Institute of Actuaries and the Institute of Chartered Accountants. To a certain extent, this remark also applies, of course, to the other accounting bodies and the Faculty of Actuaries, but to a lesser extent because the membership and the influence of these bodies are less. Many accountants would probably have difficulty in following much of the modern research work in statistics, owing to its mathematical nature, but, if we may judge by their examinations and transactions, actuaries should have no real difficulty in this respect.

Possibly the simplest way of improving statistical work in a business where little has yet been done is to appoint to the staff some one who has studied statistics theoretically, and can be encouraged to learn as much as possible of the business. Afterwards some of the younger members of the staff who do not, when appointed, possess the necessary qualifications, might be encouraged to acquire them, much as insurance offices and banks encourage members of their staffs to study theoretically the subjects with which they deal practically in their daily work.

Some Problems of the Oil Age.

American Petroleum: Supply and Demand. A Report to the Board of Directors of the American Petroleum Institute by a Committee of Eleven Members of the Board. Pp. xiv + 269. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 15*s*. net.

IT is generally recognised to-day that there are few commodities the failure of which to appear in the world's markets would cause more inconvenience than that of petroleum oil, which either as a fuel or as a lubricant is a vital necessity to many services of transport and production, apart from its still considerable use in many countries for lighting and heating.

The oil age, which began five and twenty years ago with the coming of the internal combustion engine, will probably endure for a considerable period, until

Nature and man in co-operation develop other means of power production. Nevertheless, authorities agree that the exhaustion of oil is proceeding far more rapidly than any known possibility of replacement. Men of science are only at the beginning of their investigations as to whether Nature is replenishing her stores of oil or not. It is true that there is a deep-rooted belief amongst practical oil men, based on empiricism rather than upon science, that lower down in the earth large supplies may lie, as yet only dreamt of in oil philosophy. Some support of this view is derived from the fact that the early primitive oil-wells were all shallow, and that even in 1861 Col. Drake in Pennsylvania struck oil at 69 feet.

At the present time, much oil comes from wells of 2000 to 3000 feet, and occasionally deeper. Oil technologists are not unnaturally beginning to talk of putting the drill down to oil sands at 5000 feet, whenever and wherever the prospect of a sufficient and remunerative supply may justify such a course. Oil will also be worked in due season to a far greater extent than at present from shales and other oil-bearing materials, which exist in large quantities in many other countries besides America. This latter source of supply may conceivably meet the oil needs of the world long after natural oil is wholly or nearly exhausted. It is not practicable, however, to say definitely long beforehand when a particular deposit will be ripe for commercial exploitation, since this depends on the richness of the material in oil and by-products as well as upon cost of working and the degree of competition of natural petroleum.

In Great Britain the consumption of oil products, including supplies to ships' bunkers, exceeds five and a half million tons per annum, nearly all imported. The United States uses about twenty times as much oil as we do with a population three times as great as ours. But America is at one and the same time a producing, importing, refining, consuming, and exporting country in the matter of oil. Many countries depend in whole or part upon the U.S.A. for supplies of lighting and lubricating oils and motor spirit. A possible extension of imports of oil into U.S.A. may occur, but will she maintain or restrict her exports? British supplies of oil products are drawn principally from Persia, America, the Dutch East Indies, and Mexico, with some production from Scottish shale and a modest amount of benzol from coal.

There is no need further to labour the point that the most advantageous use of Nature's stores of oil, coal, and water-power is and must always be of widespread interest. We may welcome, therefore, the thought-stimulating report recently published by the American Petroleum Institute on the prospects of oil supply and demand over the next fifty years in the United States. Though the report is limited geographically, the estimation which it contains of general factors likely to affect oil production and consumption is of wider than purely American interest. The report is in the main a business document on an economic basis and is only incidentally scientific and technical. It is no disparagement of so complex a survey to say that reality is likely to differ from estimate in many cases, seeing that numerous disturbing though occasionally counter-balancing factors must arise. Even general tendencies may be deflected and greatly modified. Nevertheless, the report is valuable from its wide outlook notwithstanding the geographical limitation which has been imposed.

A previous American oil estimate, known as the "White-Steburger," dealt, some six years ago, with the potential oil reserves of the whole world, but on a geological rather than an economic basis. That survey created some uneasiness from the suggestion that American fields were rapidly nearing exhaustion and that supplies in other countries, of natural petroleum at any rate, would probably meet requirements only for some sixty years or so. Men of practical experience in the oil trade in America and elsewhere were able to allay anxiety to a considerable extent by pointing out, on the basis of past experience, that the oil industry usually does much better in actual output than might be prognosticated by prudent men of science working upon uncertain data and necessarily incomplete investigation. The increase since then of production in California and Texas and in fields outside of the United States has confirmed the impression that the "White-Steburger" estimate was an extremely conservative one.

The 1925 report bears the signatures of eleven men of recognised standing in the American oil industry. No attempt is made therein to frame an estimate of the potential quantity of oil in lands in the U.S.A. "not yet proved," which are classified as "areas within which oil-fields may be found," of a total area exceeding eleven hundred million acres. The "present producing area" is about two million acres and "proved undeveloped areas" amount to another million acres approximately. The number of American wells now producing is about 300,000, yielding an average of one ton a day each. The world's production of crude oil in the last sixty years has practically doubled itself every ten years or so, until it has reached an annual total of about 136,000,000 tons, of which the American proportion is about 70 per cent.

The oil trade, however, has now reached a point at which a steady rather than a sensational progression may be expected. It is stated in the estimates in the report that existing proved fields may yield by normal flowing and pumping some six or seven years' supply, but it is anticipated that, if prices and products should justify a more complete draining of wells by water-flooding, mining, and other intensive methods, some five times that quantity may be obtainable in addition. Oil is expected to be found also at lower depths than those of existing wells, and eventually will be largely produced from shale, coal, and lignite. The liquid possibilities of these three classes of solids run into billions of tons and might last for centuries From one source or another, with adjustments as between oil, coal, and water-power, and allowing for economies in methods of production and utilisation, America expects to meet its oil needs for many years beyond the period of fifty covered by the report.

On the side of utilisation, the expectation is that motor facilities will be still more widely used. The report visualises "a nation on wheels." The present "saturation point for automobiles" is estimated at 27,000,000, *i.e.* one family, one automobile. The power production of cars in one year is 3,600,000. The U.S.A. population and number of families in 1950 are estimated each at about 50 per cent. increase over the figures of 1920, and the number of automotive engines, including motor cycles and aeroplanes, is calculated to reach by 1950 a total of nearly forty-five millions, as compared with some fourteen or fifteen millions in 1924. "Some figures!" But wonderful things happen where oil is concerned. It must not be supposed that the demand for motor spirit will be proportionately increased. A far lower rate of consumption is expected with improved engines. Britishers will compare the American 1924 figures with their own modest total of less than one and a half million motor vehicles, and will also hope for engines that will give them an additional mileage per gallon. In addition to the early adoption of more economical automotive engines of the types that use motor spirit, an increase is also looked for in the case of Diesel engines, in which heavy residual oil is used on a more economical basis than for steam raising. British marine engineers have recognised the advantages of the Diesel engine in many types of ships, but they have faith in steam turbines for very high-powered vessels. On this side of the Atlantic improvements of the turbine are anticipated, which incidentally may economise fuel consumption whether oil or coal.

Intensive drilling and refining, and the use of geophysical apparatus and other means as an aid to oil exploration, are well known to technologists generally, who are also watching progress in various methods of extraction of oil from coal and the further development of electricity by water-power. These matters are suggestively touched upon in the American report, but in some cases very sketchily. We are not carried very far when we are told that developments "may prove the possibility" of the utilisation of finely powdered coal or coke either by itself or in suspension in fuel oil, fed to motors. The data of actual tests under working conditions are needed to indicate whether real progress has recently been made or not.

Our brief study of this subject on the whole confirms the expectation of many good authorities that the replenishment of the world's cruse of oil will be maintained for some considerable time to come.

The Inspiration of Chemistry.

Three Centuries of Chemistry: Phases in the Growth of a Science. By Prof. Irvine Masson. Pp. vi+191. (London: Ernest Benn, Ltd., 1925.) 10*s*. 6*d*. net.

IT is a common complaint that men of science do not write readable books. We hear it especially to-day among those who, despite their complete ignorance of science, are known as "well-educated" people. The complaint is levelled in particular against representatives of physics and chemistry Naturalists, it is said, have done better; even Darwin's great original contributions to science were issued in the stream of general literature and were intelligible to the non-scientific. The complaint about physicists and chemists has recently grown louder, because educated people know it is in physics and chemistry that great things are happening. It is exasperating to feel that vast horizons of new knowledge are being opened out, that something like a revolution of thought is taking place, and yet not to be able to get some clear notion of it. True, some excellent simple expositions of this new science have been written. They fail, however, because there is nothing to which they can be linked in the mind of a reader with no knowledge of the elementary principles of the old science. Unless he has something like a vista of the chief facts and the chief stages in the development of our knowledge of physics and chemistry, how hopeless it is to give him any conception of what the new knowledge really means!

We, who live in science, are apt to say that we are not answerable for this grievous popular ignorance. No doubt that is true to some extent, perhaps to a large extent. But it is not wholly true. Leaving aside the influence which our world has exercised on school-science, there remains the question whether we have not failed in another direction.

It must almost inevitably happen that the days of formal education leave a man very defective in knowledge—it may be almost blankly ignorant—of some department of human thought. Consider, for example, the young men coming to-day to study in our universities in numbers, without any training in the language, literature, and history of Greece and Rome—without even any knowledge of "roots" to unmask the pretensions of words like catalysis and karyokinesis, or to elucidate even the simplest Latin etymology. These people, if they have mental health, will in time seek to cover their intellectual part-nakedness; and they will not find it difficult. They may forgo the grind of grammar and forgo even the learning of the languages altogether, and yet obtain, in an easy-chair, some abiding comprehension of what Greece and Rome meant to humanity and some share of the gifts they have bequeathed us.

Let us suppose the commoner case of our middle-aged or elderly contemporaries, who left school and college after an education that excluded any enlightenment in physics and chemistry. What can be done with them? What are they likely to have done for themselves to repair the omission? Nothing. But let us not be too hard on them. It is not easy to pursue laboratory work in the leisure and precincts of the average home. Attempts to do this were made at another great period of chemical upheaval. Even Dr. Johnson himself discovered a "love of chymistry which never forsook him." Boswell unfortunately is very meagre in this part of his story. He observed in Johnson's library "an apparatus for chymical experiments," and records coldly that at the age of seventy-four years the Doctor "attended some experiments that were made by a physician at Salisbury on the new kinds of air." Of what Johnson himself did, the only occurrence that seems to have roused his biographer to animation and detailed record was the great man's purchase of an ounce of oil of vitriol, for a penny instead of an expected three-halfpence. There is evidence that other men of letters of the time were striving to keep in touch with chemistry. Francis Horner, a picked man of the first Edinburgh Reviewers, attempted experiments at home, but, after some misfortunes, had to conclude regretfully that it was scarcely practicable to distil sulphuric acid in a living-room.

If we have to admit that the difficulties of amateur self-education in chemistry after school and college days reduce us to the exclusion of experiments, there seems to be only one hope left. It is that we can tell the story of the science in simple yet vivid terms, with a clear design and sequence, with vast and carefully considered elimination, with accurately timed and adjusted stress, with human regard to the discoverers as men as well as intellectual regard to their own and other men's philosophies; and we must do it with the best literary skill we can command.

It is this that Prof. Masson has attempted to do in the book before us. He has succeeded so well that a reviewer's difficulty is here to moderate duly his terms of praise. Let it be said, then, at once, that the author's equipment for his task is by no means wholly of his own making. Looking into his ancestry, a Mendelian could probably explain the exact amounts and proportions of scientific and literary talent which Prof. Masson has had as a free gift. Then there are Scotland, Australia, and the great metropolis, and great teachers that all count for a good deal. With this equipment Dr. Masson has attempted "to show the very broad foundations that were provided to sustain the present structure of science, and to what manner of men and circumstances we owe the laying and the consolidation of those bases (Chaps. i.-iv.). Next, to show in action the application of this process to chemistry, and the issue of a dominant motive which has given continuity to the whole subsequent trend of the science (Chap. v.). The ensuing phase in chemistry displays the long struggle between the new mode of thought and the ancient philosophy, ending with the eighteenth century in a solution of the central problem and a final ousting of medievalism (Chaps. vi.-x.). In the next phase the key-problem has taken on a deeper meaning, and the arrival of its successful interpretation is set forth as we know it to-day, while note is taken of the oncoming of still another era (Chap. ix.)."

The result is a book which deserves and will doubtless obtain the widest currency, for it is a work both of literature and science. It will hold the attention of "those who do not understand the technicalities of chemistry and physics, but are interested either in the evolution of modern thought or in applied logic." Above all, it will be useful to those who call themselves chemists. A real danger of these days of high pressure in chemical studies is that we may grow narrow intellectually. It would be a calamity if, in the intensive cultivation of our plots of science, we were to grow heedless of the general drift of our work. It is not at all inconceivable that science might otherwise lead to the sort of distortions and extravagances that the world has suffered, in the realms of thought and education, from the illiberality of humanists and super-humanists.

The length to which this notice has already extended precludes any comment or criticism on detail. The object has been only to indicate the high importance of the task which Prof. Masson set himself and to convey the reviewer's impression that it has been achieved with very remarkable success. He would heartily congratulate Prof. Masson on having made a most valuable and scholarly addition to general literature in the name of science.

A. SMITHELLS.

The Maori of Olden Times.

New Zealand Board of Science and Art. Manual No. 4: *The Maori as he was; a Brief Account of Maori Life as it was in Pre-European Days.* By Elsdon Best. Pp. xv+280. (Wellington, N.Z.: Dominion Museum, 1924.) n.p.

MR. ELSDON BEST has written for the New Zealand Board of Missions an account of the Maori when they first became known to Europeans, interpreted in the light of later knowledge, and by his own familiar acquaintance with native customs and ideas. The work covers the whole range of Maori anthropology.

Two distinct physical types of native are said to occur. One, long-headed and prognathous, approaches the Fijian; the other, with broader head and orthognathous, is the common Polynesian. The hair is commonly black and waved, though frizzled hair is sometimes seen.

In a chapter on traditional history, Mr. Best very briefly reviews the native accounts of the peopling of New Zealand, especially those preserved by tribes on the east coast of North Island. These traditions indicate an original Polynesian migration from lands in the west called Uru and Irihia. Following Conder and Percy Smith, it is suggested that Uru is the Biblical Ur, and that Irihia is connected with Sanskrit and Dravidian words for rice—*vrihi* and *ari*. These are mere guesses. A summary is given of the more important Polynesian voyages which led to the settlement of New Zealand.

The mythology and folklore form an interesting chapter in which the author stresses the Maori genius for personification and its application to natural phenomena, and the evolution of such myths as that of the green-stone, fabulous monsters and fairies. A summary of the religious ideas of the Maori follows, a subject with which Mr. Best has dealt more fully elsewhere (cf. NATURE, June 9, 1923, p. 790).

Like other Polynesians, the Maori were communists in social custom. The proceedings of the family, clan and tribe, and the power and prestige of the chief, were closely influenced and controlled by public opinion, and the same force maintained law and order and regulated the relations of the three classes of the community, chiefs, commoners and slaves. The Maori was a sociable being, living in village communities. He took his meals in the open, and was hospitable and fond of conversation, story-telling and amusement. Men only engaged in occupations in which *tapu* was prominent, such as house-building, canoe-making, crop-planting and the obtaining of food. In the last work women helped, especially in gathering shell-fish, but they were more especially engaged in preparing and cooking food and in the manipulation of the flax fibres and the manufacture of clothing, plaited mats and baskets. This chapter concludes with a brief account of birth, marriage and funeral customs. Birth, death and exhumation were marked by much ritual; marriage and burial by less. An infant underwent the rites of *tohi* and *pure*. The first is described by Mr. Best as a kind of baptism, the second as a greeting to the child. Betrothal, sometimes of infants, might be arranged before marriage, and marriage by capture sometimes took place. The dead were buried in a sitting position, but the remains were exhumed with much ceremony after a few years, and finally conveyed to a distant cave or hollow tree.

Mr. Best's chapter on the arts of life occupies half the book, and is exceedingly well illustrated. He describes the arts of pleasure, war, agriculture, woodcraft, textiles, clothing and ornaments, habitations and fishing. The Maori's implements were crude and primitive. Fire was produced by rubbing one stick on another. There was no loom; the cloaks of flax fibre were made by interlaced and tied threads, not by true weaving. Adzes were of stone, agricultural implements of wood. A simple drill was used, and Mr. Best figures a tree-felling machine on the principle of the Roman *ballista*. House-building is described in detail. The Maori was an expert carver. His decorative art is remarkable for curvilinear forms, in contrast to the commoner rectilinear designs of Polynesia. Tattooing was practised by both sexes; by men on face and body, by women usually on the lips and chin only.

Fishing and bird-trapping provided the chief animal food of the Maori. The dog and rat were articles of luxury. Fishing nets and traps were of great variety. Some, of immense size, astonished early European visitors.

Mr. Best has produced a very useful little book, which will inform and interest the traveller or the tourist, and provide a useful syllabus for the serious student of Maori thought and custom. There is a short bibliography, a good index, and more than 130 illustrations of persons and objects.

S. H. RAY.

Fundamentalism and Science.

The Relation between Science and Theology: How to Think about It. By C. Stuart Gager. Pp. vi+87. (Chicago and London: The Open Court Publishing Co., 1925.) 1 dollar.

THIS book is a very useful piece of anti-Fundamentalist polemic. The underlying causes of that strange reaction have been diagnosed by Prof.

Kirsopp Lake, of Harvard, as "general but imperfect education and democratic government." If that be so, perhaps the United States will not be the only country to be affected by this strange recrudescence of superstition.

No doubt Fundamentalism will one day meet its Voltaire, but he will be neither man of science nor philosopher, but theologian. It is only the theologian who can appreciate the imbecility of this revival. Properly speaking, it is not a revival, for the Fundamentalist has forgotten much of the theological thought of the past, while learning little of that of the present.

Mr. Stuart Gager has attempted to disseminate a certain amount of light where it is badly needed by delivering popular lectures, and by publishing their substance in the present volume. The book is to be commended for two reasons: (1) The author has taken a good deal of trouble to understand and to explain what is really meant by literary criticism of the Bible, and (2), he has concentrated not upon the *results* of the natural sciences, but upon the *method* of science in general. Thus, he has gone the right way to work; for no one who has a clear grasp of the methods and results either of the literary and historical criticism of the Bible, or of the natural sciences, would find Fundamentalism intellectually or emotionally attractive It is really a question of whether a person is or is not capable of following an argument, or weighing evidence, or indeed used to any kind of systematic thinking Neither Mr. Gager nor an angel from heaven could do much for people whose limitations or obstinacy preclude them from availing themselves of his help

Mr. Gager's title—"The Relation between Science and Theology," not "Science and Religion"—indicates that he understands the nature of the problem; for the quarrel is not between the incommensurables, science and religion, but between science and some particular theory about our religion, its origin and its meaning. In justice to theology it has to be remembered that Fundamentalist theology, unlike that, for example, of St. Thomas Aquinas, is intellectually not respectable.

The general reader will not find this book any less valuable on account of its somewhat naive metaphysical point of view. For example, the conceptions of *cause* and *change*, though they play some part in the argument, are not subjected to any radical analysis. But Mr. Gager is not writing for students of Kant, who rarely succumb to the seductions of Fundamentalism.

Mr. Gager's work, simple, straightforward, and well informed, deserves a wide circulation; especially perhaps in some parts of the United States, where theological thought seems to be more remote from the precincts of reason than it is, at present, in Great Britain.

J. C. HARDWICK.

Our Bookshelf.

Le Cerveau et le cœur. Par Prof G. Fano. Traduit de l'italien par G. Caputo. (Nouvelle Collection scientifique.) Pp. vii+211. (Paris: Félix Alcan, 1925.) 10 francs.

THERE is often a baldness of statement necessary in contributions to scientific journals which freezes the interest of a sympathetic but non-scientific reader. This is partly because wide general conclusions cannot be appended to each single published contribution. At intervals, however, during a career of scientific work, it is possible for some to touch on the deeper aspect of things. Prof. Fano has published a series of lectures in book form which can be recommended to the biologist and to the general reader, to one for an attempt to probe the *causa causans* of his science, to the other for its exposition of scientific methods and of the trend of physiology.

In introducing the author to the French public, Prof. Gley says, "Fano n'est pas seulement un expérimentateur: c'est un penseur." The truth of this statement is made evident to the reader as he finds described and discussed various problems of research, each in turn. The properties of living matter are dealt with at some length and from many aspects. Probably more satisfying to the majority of readers are later chapters, which describe the effects of ablating at different levels the higher nerve centres of the tortoise, *Emys Europæa*, and the interpretation of the results in relation to the will and to inhibition. A parallel deduction might have been made from the similar work of Sherrington and of Magnus on higher animals.

Other chapters recapitulate the earlier work of the author on electrical responses of cardiac muscle and his observations on the heart of the chick, and give insight into his minute technique. The book is a useful collation, in a language other than Italian, of the researches and philosophical views of this Italian *doyen*, and takes a worthy place among its fellows in the "Nouvelle Collection scientifique" Alcan

Air Ministry: Meteorological Office. The Observatories' Year Book, 1922: Comprising the Results obtained from Autographic Records and Eye Observations at the Observatories at Aberdeen, Eskdalemuir, Cahirciveen (Valencia Observatory), Richmond (Kew Observatory), and Benson; in continuation of the former British Meteorological and Magnetic Year Book, Parts 3 and 4. (M.O. 259) Pp. 337 + 6 plates. (London: H.M. Stationery Office, 1925.) 63*s*. net.

THE elements dealt with in the volume are barometric pressure, air temperature, humidity, rainfall, sunshine, wind velocity and direction, cloud and general weather. Records are tabulated for each hour. Details are given of the exposure and surroundings of the different instruments, and photographs show generally the position of the instruments. The work consists mostly of tabular results closely printed. Much information is afforded for minute study on various subjects of meteorological importance. At Eskdalemuir the diurnal variation in the components of magnetic force on quiet and disturbed days is given. The variation of the several components is shown by diagram for the year and for the several seasons, and average results are given for the years 1911–1921; special attention is also given to seismology. At Valencia the outstanding features for 1922 are said to be the cold weather of April, the prolonged low temperature, practically continuous from the middle of June to the beginning of November, and the small rainfall of October and November. At each of the four observatories (omitting Benson) the highest temperature during the year occurred at the end of May, and the minimum about the middle of January; at Kew the minimum reading was repeated on April 2, the highest and lowest readings occurring within 52 days of each other. The largest hourly measurement of rain at Aberdeen, Eskdalemuir, and Kew occurs in day hours between 8 A.M. and 5 P.M.; at Valencia it occurs between 1 and 2 A.M. The smallest hourly measurements occur between 7 A.M. and 1 P.M., except at Eskdalemuir, where it occurs from 8 to 9 P.M.

The Hidden Zoo. By Leslie G. Mainland. (The Broadcast Library.) Pp. 205+8 plates. (London: Hodder and Stoughton, Ltd., 1925.) 3*s.* 6*d.* net.

MR. MAINLAND is already well known as a delightful writer of popular articles on the Zoo, and this book is no less fascinating and amusing than his earlier volumes. In this collection of articles the author takes us behind the scenes at the Zoo and tells of the worries and anxieties of keepers and staff, and of the amusing and sometimes disastrous escapades of some of the animals. Its chief merit is, perhaps, the revelation which it makes of the large amount of careful and valuable research work which has to be done and is done by the staff in their endeavours to secure the best possible results for the animals in captivity, and the care which is constantly exercised in order to obtain the most natural conditions, consistent with confinement, for their charges. The nature of the correct food, the times at which it should be given, the rearing of the young, even the breeding of suitable foster mothers for the young of birds, are all matters demanding close observation and experiment. Mr. Mainland tells how these problems have been faced and solved. The book is charmingly written in humorous vein and is eminently suitable for reading to children. Yet the professional zoologist will find in it all sorts of odd facts of natural history of real scientific interest.

Food and Health. By Prof. R. H. A. Plimmer and Violet G. Plimmer. Pp. vi+64. (London: Longmans, Green and Co., 1925.) Paper cover, 2*s.* net. Cloth, 3*s.* 6*d.* net. Food Chart, 3*d.*

THE purpose of this little book is to explain to a lay public the principles on which a complete dietary is based, directing special attention to the errors which are commonly made in the selection of foods for human consumption. The central idea is comprised in a "square meal" expressed diagrammatically; the carbohydrates and fats or the "fuel foods," together with water and salts, constitute a central circle, whilst the four corners to form the square are filled up by proteins of good biological value and foods containing one of the three vitamins respectively. A coloured diagram shows at a glance both those foods which should be included in a complete dietary and also those of similar nature which should be either excluded or, if included, should not form the staple representatives of their class. The authors consider that the average dietary contains too little vitamin B to balance the remaining constituents, especially the carbohydrates. The work is written in a pleasant style and can be read with profit not only by the public, to whom it is more immediately addressed, but also by those whose training should enable them to express an authoritative opinion on the subject.

Úvod do Chemie Radioaktivnich Látek. By Dr. A. S. Russell. Translated by Prof. Dr. A. Šimek. Pp. x+116. (Brno: A. Piša, 1925.) Kč 20.

ALTHOUGH it was Bohemia which supplied the classical pitchblende in which radium was first detected, the Czech scientific literature does not possess any volume on radio-activity. Dr. A. Simek, who is professor of physical chemistry at the Masaryk University of Brno, has, therefore, translated Dr. A. S. Russell's "Introduction to the Chemistry of Radio-active Substances" into Czech for the benefit of his students.

In his preface the translator points out that to write a treatise on a subject of this kind, the author must himself have conducted extensive original researches on the phenomena of radio-activity. This was one of the reasons for selecting Dr. Russell's text-book, which is also better adapted for translation than the more comprehensive treatises, since the latter would be in need of revision almost as soon as the translation was in the hands of the student.

The Czech edition closely follows the original work, but additions have been necessitated by the latest progress in this ever-expanding branch of physical chemistry. In his preface Dr. Šimek acknowledges the author's careful revision of the original English edition for the purpose of bringing the translation entirely up-to-date.

Strength of Materials. By Prof. Alfred P. Poorman. Pp. xi+313. (New York: McGraw-Hill Book Co., Inc., London: McGraw-Hill Publishing Co., Ltd., 1925.) 15*s* net.

THERE appears to be a large demand in the United States for good engineering text-books of a theoretical type but of rather elementary standard. According to the preface, the present work is intended ". . . for use in undergraduate courses in Mechanics . . ." and it might serve as a useful introduction to the subject in the junior classes of engineering schools in Great Britain. The ground covered is not extensive, being confined to a discussion of the more ordinary problems in the theory of beams, shafts, and columns. Combined stresses are only dealt with in a few very simple cases, and the amount of elastic theory given is decidedly meagre, even for an introductory work. A large number of practical examples to be worked by the student are distributed throughout the work, appearing at the end of almost every article. The book is, however, carefully written, and the various figures throughout the text have been admirably reproduced. The treatment of the subject matter follows orthodox lines, and two chapters in the later part of the book are devoted to special methods of solving problems on the deflexion of beams.

E. H. L.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

An Ancient Wooden Structure at Ipswich.

In the course of excavations—carried out by means of a grant from the Percy Sladen Memorial Fund—in the brickfield of Messrs. A. Bolton and Co., Ltd., in the northern portion of Ipswich, a discovery has been made of the remains of a wooden structure that may be of considerable antiquity. As is widely known, there are preserved, in places, in the sides of the small, dry valley where the brickfield is situated, two superimposed "floors," or occupation levels, in which a large number of flint implements, flakes, and hammer-stones, together with hearths, fragments of very coarse and primitive pottery (these were found at two sites only), mammalian and some human bones, have been discovered The investigation of these "floors" has been conducted, at intervals, for the last fifteen years, and, during this period a very complete knowledge has been acquired, both of the type of specimens occurring at these levels, and also of the geological happenings since the time when these prehistoric remains were deposited in the valley.

The excavations that have been carried out this year were confined to the north-east part of the brickfield, and have exposed, in the small escarpment of the valley at this spot, the following deposits: (1) surface humus to 9 inches; (2) sandy, stony hill-wash to 8 feet, passing into (3) reddish sand, with small ferruginous concretions, often tubular in form, to 2 feet; (4) traces of Upper Floor resting unevenly upon (5) grey sand, to 2 feet, with (6) Lower Floor at base, resting unevenly upon (7) yellow sand. This yellow sand, upon which the lower floor rests, is found also on the south side of the valley, and, where containing water, has in it numerous roots of trees—*Pinus sylvestris*—that flourished, evidently, on the ancient land surface represented by the lower floor. It may be assumed that the sand was dry when these trees—which do not favour wet ground—were growing, and the preservation of their roots is almost certainly due to the present water-logged condition of the sand.

In the recent excavations a quantity of these roots were met with in the sand underlying the lower floor, and it was at this latter level that the remains of the wooden structure—now to be described—were found. As will be seen from Fig. 1, this consists of two short pieces of wood, of plank-like form, which overlap where they meet, and were placed with one of their longer edges buried superficially in, and more or less vertical to, the surface of the underlying sand. The "plank" nearest the observer is 2 feet 6 inches in greatest length, three-quarters of an inch in greatest thickness, and 8 inches in greatest width; while that farthest away from the observer is 1 foot 10 inches in greatest length, 1¼ inches in greatest thickness, and about 7 inches in greatest width.

These pieces of wood, which, by their characteristic form, were evidently split off a trunk of large size, are of oak, and exhibit, on one or other of their surfaces, clearly defined marks of cutting with some kind of axe. Behind these planks, that is, on the side farthest away from the observer, were piled a quantity of flints and other good-sized stones, and a row of (?) larch stakes, not set closely together—roughly pointed, and driven to a depth of about 1 foot into the underlying sand. These stakes—one of which can be seen in the photograph (Fig. 1)—have most of their upper portions missing, and were not inserted vertically, but inclined at an angle, with the sand surface, of about 45° towards the east: the apex of the angle formed by the intersection of the ends of the two planks (Fig. 1) pointing, approximately, to the north-west. Between the planks, and the supporting mass of stones, were found traces of clay in which were partially embedded numerous branches of (?) larch, and it is supposed that these branches, together with the missing upper portions of the stakes described, extended for some distance above the planks, and afforded a shelter from the sun or wind. The heap of stones farthest away from the observer (Fig. 1) was, unfortunately, moved before the photograph was taken, but occupied, originally, a position in close contiguity to, and about opposite the middle of, the "shelter," and, as among this heap there were found hammer-stones, one large, roughly-made *racloir*, numerous flakes, and some burnt flints, associated with blackened, carbonaceous sand, it seems that there was some sort of habitation where the manufacture of flint implements was carried on.

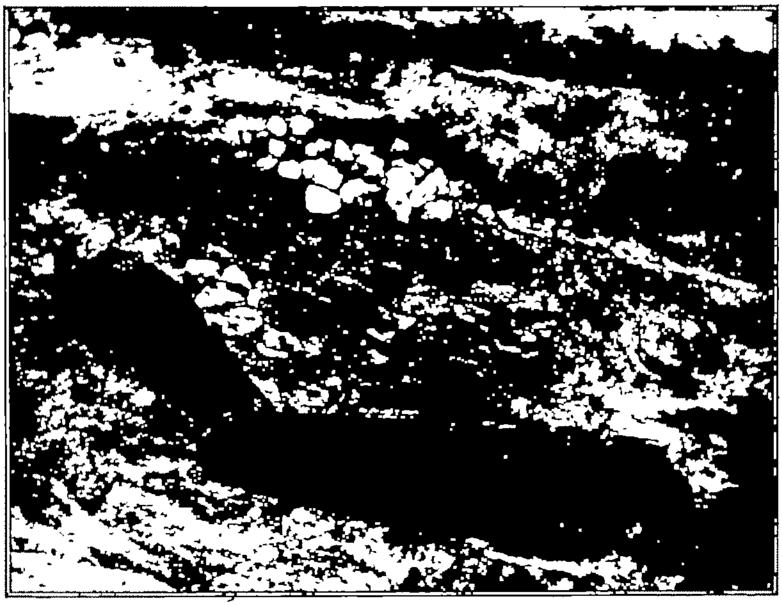

FIG. 1.—Remains of wooden structure *in situ* in the lower floor in Messrs. Bolton and Co.'s brickfield, Ipswich.

The artefacts mentioned are in every way comparable with others found in the lower floor in the immediately surrounding area and throughout the brickfield, and the wooden structure described was buried beneath (1) surface humus, 4 inches; (2) reddish sand with small ferruginous concretions, to 18 inches; (3) greyish sand, vaguely stratified, to 2 feet 6 inches; and (4) black, peaty sand, to 1 foot (this sand is evidently the lower part of layer 3). These strata appeared to be quite unbroken, and, with the exception of the humus, to be continued into the neighbouring escarpment, where the level at which the structure rested is covered by about 13 feet of deposits.

Fig. 2 shows the condition of the strata overlying the wooden structure before it was completely uncovered. As will be seen from Fig. 1, there was no trace of a continuation of the habitation to the east, and my present opinion is that it represents all that remains of a primitive shelter of some kind. But I admit, frankly, that I have never seen any structure of this kind before, and I have no wish to be in any way dogmatic as to its original form, or use.

The flint implements, together with a series of specimens made from non-flint rocks, found in the lower floor, were regarded by the late Prof. V. Commont, and other archæologists, among whom I am to be numbered, as referable to a phase of the Upper Mousterian, palæolithic, culture, but Prof. Henri Breuil, and several investigators, believe the specimens must be assigned to some early portion of the neolithic period. Further, though I have little doubt that the valley in which these ancient floors occur has been deepened since their occupation by man, and a considerable thickness of hill-washes of, apparently, different ages, deposited over these occupation levels, yet it is not, at present, possible to say with certainty to what particular time, after the deposition of the Upper Chalky Boulder Clay of the Ipswich district, these events are to be referred. The north-east portion of the brickfield where the wooden structure was found has been inhabited by rabbits for a very long period, and their activities have, in some cases, carried pieces of Roman bricks, and other objects, to a depth of many feet. The majority of the Roman remains of the area occurs, however, in, and just beneath, the surface soil, and though two small pieces (the presence of one of these may, probably, be accounted for by supposing it to have been thrown in with the material used to cover up the structure after discovery, so that it could be examined *in situ*, by other archæologists, before removal) of brick were found within a yard or two of the structure, and at a similar depth from the surface, I find it difficult to believe that the habitation itself is of Roman date, especially as the strata above it showed no signs of disturbance, as is so apparent in graves of this period in the high ground to the west.

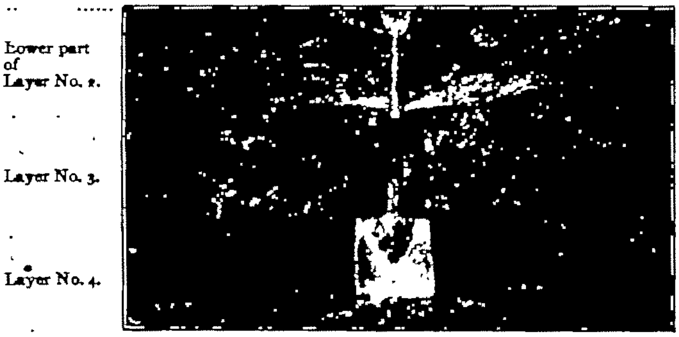

FIG. 2.—Section above wooden structure found in lower floor of Messrs. Bolton and Co.'s brickfield, Ipswich.

The site where the structure was found is now completely water-logged, and there is no doubt that this condition accounts for the preservation of the wood, which, however, has had to be kept immersed in a suitable liquid to prevent its disintegration. This work has been undertaken by Mr. Guy Maynard, curator of Ipswich Museum, who also took the excellent photograph showing the structure *in situ*. About 15 yards to the west of where the discovery of the habitation was made, traces of what appeared to be another were found; only in this case a portion of one of the stakes, and some small branches, were alone preserved. The condition of the wood found, which, by experiments I have carried out, could, I believe, have been shaped by a sharp flint, and split off a trunk by means of wedges of stone, though, of such widely different antiquity, exhibits a similar appearance to many of the branches and other parts of trees found in the Cromer Forest Bed of Norfolk.

At a later date I hope to publish a fully illustrated and detailed account of this discovery.

J. REID MOIR.

One House,
Ipswich.

The Solar Constant and Terrestrial Magnetism.

A LETTER in NATURE, November 28, p. 785, under the above title by Dr. G. C. Abbot, discusses a recent paper of mine in the *Proceedings of the Royal Society*. It refers to two of the subjects investigated in my paper, the 27-day interval, and the relation between corresponding daily values of S (the solar constant), as published by Dr. Abbot, and of C, the international character figure, intended to supply a measure of magnetic disturbance. To take the second question first, Dr. Abbot's statement is as follows: "Dr. Chree does find indications of magnetic disturbance associated with low values of the solar constant. Inasmuch as higher solar constant values are generally associated with numerous sunspots and abundant magnetic disturbances, he thinks this paradoxical finding of low solar constants associated with magnetic disturbances is non-significant. On the contrary, it is exactly what we should expect . . . the passage of an individual sunspot group over the central meridian of the solar disc is almost always associated with decreased values of the solar constant, and doubtless frequently with terrestrial magnetic disturbances. Hence it is prevailingly with low rather than high solar constant values that individual magnetic disturbances will be found associated."

What I actually did was to take for each month of 1923 the 5 days of largest S and the 5 days of smallest S. This supplied 60 days representative of high and 60 representative of low solar constant. Calling the representative day in either class n, I calculated from the De Bilt annual table the mean value of the magnetic character C for day n and the associated 4 subsequent days. The results were as follows, A denoting the group in which n was the representative day of high S, and B the group in which n was the representative day of low S.

VALUE OF C.

Day.	n.	$n+1$.	$n+2$.	$n+3$	$n+4$.
A	0·39	0·49	0·48	0·46	0·47
B	0·50	0·51	0·57	0·60	0·55

The mean value of C for 1923 was 0·48.

Dr. Abbot's explanation does not seem to me at all to fit the facts, even if for a moment we accepted them as exact physical data. What it should lead to would surely be a decided excess in C in the day n of group B over the mean value for the year. Now the excess is only 0·02, and no one, I should think, who knows anything of magnetic character figures would accept this as significant. If any of the figures are significant, it is the low value of C in day n of group A, and the high values of C on days $n+2$ and $n+3$ of group *B*. But on these figures Dr. Abbot's explanation seems to throw no light whatever.

The results did not encourage me at the time to prosecute the inquiry further. But in view of the weight naturally attaching to Dr. Abbot's views, I have now extended the investigation to 1921, 1922 and 1924, so as to cover the four years for which Dr. Abbot claims the highest accuracy in the values of *S*.

If the cause suggested by Dr. Abbot were sensible in 1923, the year of sunspot minimum, we should expect it to be conspicuous in the other three years, which had on the average a sunspot frequency more than three times as large. The results are given in the following table, *A* and *B* distinguishing the two groups of days of high and low solar constant as before. Instead, however, of the absolute values of *C*, I give in each case the algebraic difference from the corresponding mean from all days. Only 11 months were available for 1924, but as much weight has been allowed to this year as to the others. The mean character figure for the four years combined was 0·575.

VALUE OF *C*.

	Day	*n*.	*n*+1	*n*+2	*n*+3	*n*+4.
A	1921	+0·05	+0·10	+0·03	−0·05	−0·03
	1922	+0·05	+0·05	−0·02	+0·02	−0·05
	1923	−0·09	+0·01	0·00	−0·02	−0·01
	1924	−0·02	+0·08	+0·12	+0·02	−0·05
	Mean	0·00	+0·06	+0·03	−0·01	−0·035
B	1921	+0·11	+0·07	+0·08	+0·08	−0·04
	1922	+0·01	−0·05	0·00	0·00	0·00
	1923	+0·02	+0·03	+0·09	+0·12	+0·08
	1924	−0·07	+0·01	+0·02	+0·04	+0·11
	Mean .	+0·02	+0·015	+0·05	+0·06	+0·04

There is no column in which the higher value of *C* does not appear in the group *A* days in at least one year out of the four. In column *n* it occurs in group *A* in two years, and in column *n* + 1 in three years. No column gives a larger mean value for *B* than column *n* + 1 gives for *A*. If we omitted 1923, the year of sunspot minimum, the mean value of *C* in column *n* would be higher for group *A* than for group *B*. It will, I trust, be generally admitted that my attitude towards the data of 1923 has been justified.

There is nothing perhaps in the results now obtained incompatible with Dr. Abbot's belief as to the screening effect on ordinary solar radiation of sunspots when over the central meridian. If, however, such screening has a sensible effect on the solar constant, the apparent absence of a 27-day interval in the values of *S* becomes increasingly strange. If this interval had been prominent in even a few months of the four years, the method which I employed for detecting it should not have led, as it did, to a wholly negative result. Dr. Abbot's comments on this result leave me in doubt whether he believes that the 27-day interval, while not exhibited by *S* in recent years, was a true phenomenon in the earlier years, *e.g.* 1915, when he recognised it. If the phenomenon were real, we should have expected it to be shown the more clearly the more accurate the observations. In the case of magnetic data, it has shown no tendency to become less prominent since 1915. Perhaps I may say frankly that one of my reasons for investigating the matter was that I felt that my assurance that the apparent day-to-day fluctuations in *S* represented real fluctuations in the sun would be materially strengthened if they exhibited the 27-day interval clearly.

C. CHREE.

December 11.

Passivity, Catalytic Action, and other Phenomena.

THE writer's view of the passivity of chromium, manganese, iron, cobalt and nickel (NATURE, March 28, 1925, 115, p. 455) may now be extended and correlated with the recent work of H. S. Taylor (*Proc. Roy. Soc.*, 1925, A, 108, p. 105) and of E. F. Armstrong and T. P. Hilditch (*ibid.*, p. 111) on catalytic action at the surface of nickel, with that of J. Heyrovský (*Rec. trav. chim.*, 1925, 44, p. 499) on overvoltage, and with that of T. M. Lowry on the nature of chemical action. This view is based on Bohr's distribution of electrons within the atom. It supposes that in the elements mentioned the number of electrons in the outermost orbit is "ideally" between one and two, and is therefore either one or two, and that in consequence the atoms of such elements can never be electrically neutral in the same sense as atoms of sodium or of zinc. The experimental evidence favours calling the state with one electron in the outer orbit passive, and that with two electrons in the outer orbit active. The difference in potential between the two states of each of these metals is about 1 volt.

This Jekyll and Hyde explanation of passivity appears to differ *in toto* from the ordinary view which ascribes passivity to a protective film. It leads to a simple explanation of the non-corrosion of stainless steel. It is known that stainless steel is electrochemically nobler than copper. Now I find that both chromium and iron when passive lie between copper and bismuth in their susceptibility of being attacked by acids, although when active they are more reactive than cadmium. I find also that passive chromium and passive iron are closer in reactivity than are active chromium and active iron. I am less sure, although I have some experimental evidence in favour, that both iron and chromium when in true solution in a second metal become passive. It is known that chromium and iron are in solid solution in stainless steel. Each therefore may be regarded as passifying the other. It follows from what has been said that stainless steel should act like a nearly homogeneous metal which is nobler than copper, and this is what it is known to do.

It is known that some of the metals of the palladium and platinum groups and of the metals with "coloured ions," titanium, vanadium, chromium, manganese, iron, cobalt, nickel, copper, niobium, molybdenum, tungsten and uranium differ remarkably from other metals in their power of adsorbing certain gases and catalysing gaseous reactions. If the physicists will grant that atoms of these metals may conduct an electron from one reacting molecule to another, it is possible from a chemist's point of view to relate adsorption and catalytic action with passivity.

(*a*) I regard the metals mentioned above as being potentially able to exist in both active and passive forms, one of which is stable; thus manganese and iron are normally in the active form, and nickel and platinum in the passive form.

(*b*) I think these metals are best able to adsorb gases and to act as catalysts when in the passive form.

(*c*) They adsorb, because of their property of never being electrically neutral, a molecule which is capable of exhibiting polarity, the negative part of the molecule being attracted to the outside and the positive to the inside of the atom.

(*d*) They catalyse a reaction between A_2 and B, where A represents an atom, and A_2 and B molecules, because of their potentiality of passing from the passive to the active form. This may occur when the outer orbit gains an electron from A_2 or B and the inner orbit expels one on to B or A_2 (as well as in the normal way by gaining an electron from an inner orbit) so that the reaction may go

$$A_2 + B \longrightarrow A_2^+ + B^- \longrightarrow A_2B,$$

or $A_2 \longrightarrow A + A$, followed by $A + B \longrightarrow AB$;

the active form of the catalysing atom then reverts to the passive, either spontaneously or as a result of either final reaction. In other words, my view is that the reaction takes place because the passage of an electron from A_2 to B activates both, and that the catalysing atom is the conductor of this electron.

An example will illustrate. When metallic cadmium is shaken with dilute sulphuric acid, some of its atoms expel electrons to form ions, and in so doing discharge hydrogen ions to form atoms of hydrogen on the metallic surface. The chemical activity of these atoms is a simple function of the reactivity of the cadmium. These atoms are known to combine very slowly with each other, and this is expressed by saying that cadmium has a high hydrogen overvoltage. If a little platinum, tungsten or molybdenum be deposited on the cadmium, combination of the atomic hydrogen proceeds rapidly, and these metals are said to have a very low overvoltage. The view expressed in (*d*) shows how this occurs, and explains why the metals which exhibit passivity alone have very low overvoltages In this case the reactions are

$$H + H \longrightarrow H^+ + H^- \longrightarrow H_2.$$

This is in accord with recent work by J. Heyrovský on the dropping mercury electrode, who shows that the passage from atomic to molecular hydrogen is better represented by the changes $2H \longrightarrow H^+ + H^- \longrightarrow H_2$ than by the change $2H \longrightarrow H_2$.

These views also carry those of H. S. Taylor, E. F. Armstrong and T. P. Hilditch on one hand, and those of I. Langmuir on the other, a definite step further. The former think that in a hydrogenation process at the surface of nickel, both reactants are attached to a single atom of nickel; the latter thinks that the reactants are adsorbed on adjacent atoms. In both cases the adsorption of the reactants is explained by the fact that nickel is not electrically neutral in the same sense as is zinc, and, in the first case, the subsequent reaction is explained by the mechanism given in (*d*) above, namely,

$$A_2 + B \longrightarrow A_2^+ + B^- \longrightarrow A_2B.$$

Since the passage from the passive to the active form involves the expulsion of an electron from an inner orbit, it is possible that when this change occurs in the presence of an adsorbed molecule, this molecule will be split into atoms, $A_2 \longrightarrow A + A$. This suggests an explanation for the well-known but unexplained observation that gases adsorbed on nickel, platinum, palladium, etc., are sometimes in the atomic condition. When a second molecule B comes sufficiently near to this atom and is capable of reacting with it, the reaction $A + B \longrightarrow AB$ occurs as I. Langmuir thinks.

A. S. RUSSELL.

Christ Church, Oxford,
December 8.

Weather Prediction from Observations of Cloudlets.

MAY I refer to the first letter of Sir G. Archdall Reid? (NATURE, November 7, p. 676). He says: "If then the behaviour of the smallest and thinnest fragment of cloud that can be clearly isolated be watched, it is usually possible to predict very quickly and with fair confidence the state of the weather for the next few hours. If the cloudlet waxes visibly, rain is almost certain; if it wanes, fine weather is equally probable; if it neither waxes nor wanes, existing conditions are likely to continue." It seems to me that the method of forecasting is falsified on every day on which clouds form and when rain does not follow, and there are very many such days in the year, for the cumulus of a fine day, which is common in spring, summer, and autumn, and occurs sometimes in winter, begins its life as a cloudlet, whether the ordinary man gets up early enough to see it or not. Certainly, too, cirro-cumulus often begins its life as cloudlets, but I have never seen cumuli "wane into cirro-cumuli" and rather doubt whether any one has ever observed such a phenomenon.

I do not think that Sir Archdall Reid quite appreciates my point about cirro-cumulus: we often see cloudlets of this variety waxing in one place and simultaneously waning in another, are we to predict rain from the waxing, or fine weather from the waning cloudlets, when both prognostics are occurring at one and the same time? Lenticular cirro-cumulus is composed of cloudlets that are born on the windward side and die in the leeward side of the cloud mass; in his first letter Sir Archdall Reid gives two possible explanations of this phenomenon; I should like to mention that it was these explanations to which I referred, and not any explanation of his main thesis, for as he says he gave none.

I quite agree that the waxing of cloudlets is often followed by rain, for we cannot have rain without cloud, but I think that it is just as often not followed by rain, and I certainly cannot think that if cloudlets wax visibly "rain is almost certain," for if this were the case we should have scarcely any rainless summer days. But Sir Archdall Reid seems less certain about the method in his second letter (December 12, p. 864) than he was in his first. I may be mistaken, but it seems to me that the method is scarcely of more use than the tossing of a coin; but, on the other hand, I am not sure that I understand the second of Sir Archdall Reid's definitions of cloudlets—"small and diaphanous clouds which can be seen at the same time in every part," and it is possible that our disagreement is based on our definitions of cloudlets. It would be interesting to know what those who are more familiar with forecasting than I am think of the question.

C. J. P. CAVE.

Stoner Hill, Petersfield,
December 22.

THE correspondence on this subject in recent issues of NATURE has been of particular interest to me, because the observation of the waxing and waning of cloudlets has been made by me for the last four months in trying to forecast for the next few hours the probability of clear or cloudy weather. I may add that these observations have always been made about half-an-hour or so before sunset, for the following reason:

I have set myself the task of photographing the spectrum of a certain star on every fine night for a period of about 130 days, and I began this work on the night of September 9. The most convenient time for photographing this star is as soon after sunset as possible, when it is sufficiently dark.

As I have to go down 400 feet to get home, I prefer not to leave the observatory if the early evening is going to be fine.

On doubtful afternoons, therefore, I have studied the cloudlets, picking out the smallest and watching its behaviour. I have found that, in nearly every case, the waning cloudlet has given me for the next few hours clear weather. On the other hand, when the cloudlet increased in size I was nearly always doomed to a cloudy evening.

I have found, therefore, that this method is very successful at about the time of sunset, but have made no observations at other times of the day to test its value then. It has been most useful to me and saved me a great amount of unnecessary exertion.

WILLIAM J. S. LOCKYER.

Norman Lockyer Observatory,
Salcombe Hill, Sidmouth, Devon.

On a New Porphyrin.

CHLOROCRUORIN is the name given in 1867 by Sir Ray Lankester to a pigment, red in concentrated solution, green dilute, dissolved in the blood plasma of Serpulid, Sabellid and Chlorhæmid polychæte worms. It has been shown (Fox, *Proc. Roy. Soc.*, in the press) that the chlorocruorin molecule is constructed on the same model as that of hæmoglobin. Oxy- and reduced chlorocruorin resemble oxy- and reduced hæmoglobin spectroscopically, with the corresponding bands moved to the red in the case of chlorocruorin. In a like manner, the derivatives of chlorocruorin which correspond to hæmochromogen, hæmatin and hæmatoporphyrin resemble these substances, with the same shift of the bands to the red.

There exists a family of pigments related to hæmoglobin. These are cytochrome, a complex of hæmochromogens present in most animal and many plant cells (Keilin, *Proc. Roy. Soc.*, B, vol. 98, 1925, p. 312); heliocorubin, a hæmochromogen in the gut of snails; and actiniohæmatin, in sea-anemones. Now, hæmoglobin, part of the cytochrome complex, heliocorubin, and actiniohæmatin all contain one and the same hæmatin nucleus (Anson and Mirsky, *Journ. Physiol.*, vol. 60, 1925, p. 161). Chlorocruorin, however, resembles hæmoglobin more closely in structure than do the other members of the hæmoglobin family which have just been referred to. Nevertheless, chlorocruorin does not contain the same hæmatin nucleus as these other pigments (Fox, *loc. cit.*). The reason for the difference existing between the hæmatin of hæmoglobin and that of chlorocruorin is that, whereas both contain iron, the former hæmatin has a different porphyrin from the latter.

This can be shown by treating both by Nencki's procedure for the preparation of hæmatoporphyrin.[1] Diluted Spirographis blood was extracted with acetic acid (1 part) plus ether (3 parts). The acetic acid was washed out with water, and the remaining ether solution of chlorocruorohæmatin was evaporated to dryness. The residue (with some sodium sulphite, to prevent oxidation of the porphyrin) was dissolved in hydrobromic-acetic acid. The porphyrin was driven by sodium acetate into ether and then taken back into hydrochloric acid (1 part HCl plus 2 parts water). Hæmatoporphyrin for comparison was prepared from hæmin with hydrobromic-acetic acid. The axes of the bands of the two porphyrins (both in HCl, 1 in 3) measured with Hartridge's reversion spectrometer (*Journ. Physiol.*, vol. 44, 1912, p. 1, and vol. 57, 1922, p. 47) were as follows:

Nencki's hæmatoporphyrin . .	593	549
Chlorocruoroporphyrin (Nencki's method)	613	553

H. Fischer and O. Schumm (*Zeit. Physiol. Ch.*, numerous publications in recent years) have added much to our knowledge of porphyrins. They show that porphyrins fall into two groups.

Group I. comprises porphyrins insoluble in chloroform. It contains (1) Coproporphyrin, extracted from human fæces and from yeast by ether-acetic acid, and (2) Uroporphyrin, found in pathological urine. Coproporphyrin is the porphyrin derived from a part of cytochrome (Keilin, *loc. cit.*). Cytochrome is present in relatively considerable amounts in yeast and in bacteria. Cytochrome (in yeast) gives in addition a porphyrin of Group II.

Group II. is formed by porphyrins soluble in chloroform and having the bands to the red of those of Group I. It contains (1) the porphyrin prepared from reduced hæmoglobin in whole blood by the action of HCl (Laidlaw, *Journ. Physiol.*, vol. 31, 1904, p. 467); (2) Kämmerer's porphyrin, extracted from putrefying blood by ether-acetic; (3) Papendieck's porphyrin, obtainable from fæces after a meat meal; and (4) Ooporphyrin, extracted by HCl from egg-shells.

The following table shows the wave-lengths of the band-axes of the principal of these prophyrins:

Porphyrin.	Reference.	Axes of Bands in μμ.					
		In Ether.				In 25 per cent. HCl.	
GROUP I.:							
Coproporphyrin . .	Fischer and Schneller, *Z.P.C.*, vol. 130	624	571	528	499	594	553
Ditto	Schumm, *Z P.C.*, vol. 136	623	569	526	495	593	550
GROUP II.:							
Laidlaw's porphyrin .	Schumm, *Z.P.C.*, vol. 132	631	575	535	502	602	557
Kämmerer's porphyrin .	Fischer and Schneller, *Z.P.C.*, vol. 130	633	575	533	498	602	557
Ooporphyrin . . .	Fischer and Kögl, *Z.P.C.*, vol. 131	631	581	537	502	603	557

I next submitted chlorocruorin to a modification of Laidlaw's procedure for porphyrin preparation. Spirographis blood was treated with acetic-ether. The resulting chlorocruorohæmatin was taken into sodium carbonate solution and reduced with hydrosulphite. In a current of carbon dioxide, concentrated hydrochloric acid was then added. For comparison (1) the porphyrin from hæmin was prepared by a similar modification of Laidlaw's method, and (2) ooporphyrin was extracted from egg-shells with hydrochloric acid. The measurements of the bands with Hartridge's spectrometer are given below:

	Axes of Bands in μμ.					
	In Ether.				In 1 part conc. HCl + 2 parts Water	
Porphyrin from hæmin	632	585	536	503	600	555
Ooporphyrin .	634	587	536	504	601	556
Porphyrin from chlorocruorohæmatin	641	580	553	512	614	559

It is seen that the bands of the porphyrin from chlorocruorin are situated considerably to the red of those of any of the above-mentioned porphyrins. This new porphyrin resembles the members of Group II. in being soluble in chloroform.

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[1] I am indebted to Mr. R. Hill, of the Biochemical Laboratory, Cambridge, for valuable help.

If the composition of the porphyrin of chlorocruorin is ascertained, valuable light may be thrown on the peculiar metabolic process by which a few annelids synthesise chlorocruorin while so many animals build up hæmoglobin

H. MUNRO FOX.

Zoological Laboratory, Cambridge,
December 17.

Blindness of Cave-Animals.

I DOUBT whether Sir Ray Lankester would maintain his theory of the origin of blindness in cave-animals, at least in the fishes living in the North American limestone caves, if he had carefully considered the observations on these fishes published by Eigenmann and other American zoologists. There are two points of special significance in relation to the question of selection by the escape from the caves of individuals with better developed eyes, versus direct influence of darkness on the eyes The first is to what degree the actual ontogeny of the eye shows recapitulation, the second whether the individuals with power of vision would actually swim away from the darkness towards the light

Amblyopsis spelæus, the most abundant of the blind fishes of the caves of central North America, reaches a maximum length of 13·5 cm. It is placed in a small family closely allied to the Cyprinodontidæ. This family includes five other species occurring in the same or contiguous regions. Three of these, *Chologaster agassizii*, *Typhlichthys subterraneus*, and *Troglichthys rosæ*, also live in subterranean streams in total darkness. Two of them, *Chologaster cornutus* and *C. papilliferus*, live exclusively in streams and swamps on the surface of the earth.

If we consider the eye of Amblyopsis as the example of the subterranean species which has been most thoroughly examined, the organ is visible as a minute black spot on each side in specimens 35 mm. long Microscopically examined, it is very degenerate The lens is very small and displaced, or entirely absent. The vitreous humour has disappeared, the remnants of the retina form an irregular mass in the cavity of the eye, the optic nerve can be recognised where it leaves the eye but cannot be traced to the brain. After the mature stage of the fish the eye undergoes further progressive degeneration.

With regard to recapitulation, the lens and optic vesicle develop in the embryo at the normal stage and in the normal manner, but soon begin to degenerate. The optic nerve also develops normally in the embryo. Defects due to mutation do not usually follow a normal initial development.

In *Chologaster agassizii*, which is also completely subterranean, the eye is normal in structure, and functional, but reduced in size The fact that there are two other species of the same genus which live in daylight shows that this one cannot have been confined to darkness so long as the subterranean genera in which the eyes are degenerate and vestigial. If Sir Ray Lankester's theory were true, *C. agassizii* would not be in darkness at all but would have found its way out to the light. But it is probable that the instinct of all the species of Chologaster is not to seek the light but to avoid it. Eigenmann actually observed this in *C. papilliferus*, which is found under stones in the "springs" or small streams of south-western Illinois: the fish are negatively heliotropic, or photophobic He found that this was equally true of Amblyopsis and Typhlichthys, which, notwithstanding their blindness, have retained the habit of hiding under stones and the ledges of rocks. In Chologaster there is evidence that the reduction of the eye has commenced in association with its photophobic habits without confinement to total darkness. In a specimen of Zygonectes, one of the Cyprinodontidæ, 38 mm in total length, the eye was 2 mm. in diameter In *Chologaster papilliferus*, 32 mm. in total length, the diameter of the eye was 0·83 mm. In *C. cornutus*, 32 mm. in total length, diameter of eye 0·96 mm. In *C. agassizii*, the subterranean species, 39 mm. in total length, diameter of eye 0·72 mm

Lastly, it may be mentioned that in *Typhlogobius californiensis*, the eyes in the adult are minute and degenerate and almost if not quite insensitive to light This fish lives in holes under stones, which it never quits. It can scarcely be maintained that it remains in dark holes because defects in vision make it unable to find its way out, especially as in the young state its eyes are visible and apparently functional.

J. T. CUNNINGHAM.

East London College,
December 12

Heterochromosomes and Polyploidy.

DURING recent cytological investigations in the Salicaceæ, undertaken to demonstrate the presence or absence of sex- or heterochromosomes in certain species of Salix, I have discovered such chromosomes in the males of *Salix lucida* Muhl., *S. aurita* L., *S. cinerea* L., and *S. Andersoniana* Sm. Of these species, *S. lucida*, an American form, belongs to the section Pentandræ of the supersection Pleiandræ, *S. aurita* and *S. cinerea* to the Capreæ group of the Diandræ, and *S Andersoniana* to the Phylicifoliæ of the same supersection; all are, of course, diœcious. Of the polyploid series developed in Salix, *S. lucida*, *S. aurita* and *S cinerea* are tetraploids, and *S. Andersoniana* hexaploid

In the case of *S. lucida*, the heterochromosomes are easily discernible both in profile views of the heterotypical spindle in pollen mother cells and also in diakinetic figures. On the contrary, owing to the intimate relations between the paired chromosomes during diakinesis in *S. aurita*, *S. cinerea* and *S. Andersoniana*, they are not so readily recognisable at that stage in those species but stand out very clearly in heterotype metaphase side views.

In all four species, the larger member of the pair is more or less broadly (and occasionally obliquely) pear-shaped whilst the smaller is spherical, they lie on the periphery of the equatorial plate.

Although the mere demonstration of heterochromosomes in these species is in itself important, of even greater value is the light thrown on the development of polyploid series in plant genera. No matter what explanations are given of the origin of tetraploid species they all amount to the same in the end: whether we invoke chromosome division in the fertilised egg followed by a suspended mitosis, or any of the other theoretical explanations now current, in all there is implied a duplication of chromosome complement. Therefore, in diœcious plants possessing heterochromosomes, amongst the chromosomes so duplicated should be those chromosomes themselves, so that in the heterotype division of tetraploid species we ought to be able to detect two pairs of heterochromosomes and in hexaploids three pairs. However, careful examination has shown that in diploid, tetraploid and hexaploid alike only one pair is present. Hence, the problem of polyploid series in the Salices, and presumably in other genera, cannot have the simple solutions previously propounded, and the whole matter is thrown open for further consideration.

J. W. HESLOP HARRISON.

Armstrong College, Newcastle-upon-Tyne,
December 21.

Coal Conservation and the Gas Industry.[1]

By Prof. J. W. COBB, C.B.E., The University, Leeds.

NOTHING has contributed more to the material advancement of civilised man from the state of his primitive ancestors than the utilisation of fuel for the production of light, heat, and power. Primitive man depended on the solar hear available from day to day, and his life was circumscribed accordingly. In temperate zones like our own, the sun's rays are too feeble and uncertain to enable us to obtain from them by direct means any considerable quantity of useful power, though in certain sunny regions, such as Egypt and California, it has been attempted. Even there, the amount and the cost of the plant for the production of the unit of power was excessive when compared with methods based on the use of fuel.

Vegetation, however, is capable of absorbing and storing up the radiant energy of the sun in the formation of organic compounds, which the plant is able to build up from carbon dioxide and water. In this way enormous quantities of fuel have been and are produced, by the combustion of which we are able to utilise indirectly the radiant energy of the sun absorbed by the plant in its synthetic processes. Man is, however, too impatient now to provide his fuel supplies by tree culture from one century to another, even were the necessary land available, while similar reasons rule out the cultivation of annual fuel crops in a crowded country such as Britain, where food crops must take precedence.

In default of fuel cultivation, we are compelled to rely on the accumulated store of fossilised vegetation in one or other of its existing forms. If we examine a table (below) showing the composition of dry, ashless fuels, we see that the individual analyses show a gradual concentration of carbon at the expense of hydrogen and oxygen, so that we pass over from a substance such as dry wood or cellulose (a principal plant constituent) containing less than 50 per cent. of carbon to coals containing 80-90 per cent. and even more when anthracitic—a process which has been imitated in the laboratory, particularly in the experiments of Bergius. Accompanying this concentration of carbon is the production of a substance in which the heat energy is more concentrated, in fact a higher grade and more useful fuel. Thus 1 lb. of coal on completed combustion develops about double the amount of heat obtainable from 1 lb. of wood or cellulose, and this increases the difficulty of basing our fuel supplies on "fuel crops." The position is made worse by the fact that wood, even when air dried, contains 15-20 per cent. of moisture, and the heating value is correspondingly lessened.

	Carbon	Hydrogen	Oxygen and Nitrogen.
Cellulose ($C_6H_{10}O_5$)	44·5	6·2	49·5
Wood . . .	50·0	6 0	44·0
Peat substance .	50–64	4 5-6·8	28–44
Lignites . .	60-70	5·0	20-35
Bituminous coals .	75-90	4·5-5·5	5·5-15·0
Anthracites . .	90–95	2-4	3

In peat the concentration of carbon has begun, but the peat when freshly cut contains 80-90 per cent. of water—as much water as milk—and to make it useful as a fuel the moisture content has to be reduced to about 25 per cent. The bulkiness of peat, the problem of drying it, and its low heating value when dry, limit its value as a fuel greatly. A high nitrogen content is a point in its favour when conditions allow recovery of by-products.

Lignite is a more concentrated fuel than peat, but its moisture content may still reach 40-60 per cent. Its heating value remains low, but by drying, briquetting, and by carbonisation this fuel can often be turned to good account. It occurs usually at or near the surface and is won by mechanical excavation rather than underground mining. It is available, therefore, at the pit at a very low cost, and much of the German electric power supply is based on lignite. Abundant deposits occur and are being developed in Canada and Australia, but in Britain supplies are negligible.

The net result of this survey is to show that we in Great Britain are dependent almost exclusively on coal—a fossil fuel, a wasting asset—for the possibility of many manufacturing activities and amenities of life. The known deposits of coal in this country will suffice to meet the present rate of consumption for a long time, and improved mining technique has made available coal which a generation ago would have been thought unworkable. On the other hand, the cost of coal has increased, and coal forms a large part of the cost of producing some manufactured products such as iron and steel, on which in turn the engineering industry depends. As compared with other countries we shall, therefore, be at a disadvantage as soon as coal becomes difficult or expensive to get, even though we can get it at a price. Another consideration is the tendency to substitute mechanical appliances for hand labour, which tends to increase the consumption of coal, unless the efficiency of its utilisation can be correspondingly increased.

In considering the complete utilisation of coal, one must not overlook its potentialities as a source of chemical products. In the plant we have not only a cellulosic skeleton but also juices and spores containing resinous substances, and their degradation products form the two main types of components found in coal. It is the resinous bodies which cause many coals to fuse on heating and to evolve much gas, burning with a luminous smoky flame. It is owing to the absence of such components that anthracites burn smokelessly.

Coal when consumed in an ordinary grate goes through two stages. In the first is evolved the volatile matter, which if cooled and collected is found to consist of gas, a sticky oily liquid, tar, and a watery ammoniacal liquor. The porous solid residue, consisting mainly of "fixed" carbon with the ash of the coal, is known as coke.

The second stage of burning coal consists in the combination with oxygen of the air of both the volatile matter and the fixed carbon of the coke. In the domestic fire it is attempted to carry both processes on together. This has a certain advantage of simplicity but is unsatisfactory in other respects. Smoke cannot be avoided, especially when fresh coal is added to the fire, for the two stages of combustion can scarcely be kept in step, and incompletely burned tarry matter escapes up the chimney producing smoke. Such fires have a low efficiency. Only 20-25 per cent. of the heat of the coal is radiated into the room, while attendance to a fire involves labour and dirt.

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[1] From a paper, entitled "The Conservation of the Nation's Store of Solar Energy," read at the Conference of the British Commercial Gas Association at Plymouth, October 21, 1925.

The use of electricity instead, generated from the coal, has obvious attractions, but however efficiently it may be applied in the home, it must always be remembered that it carries on an average 10 per cent. and at best 20 per cent. only of the original heat of the coal. This 80-90 per cent. initial loss is too severe a handicap and entails an enormous waste of heat, though not apparent to the consumer. It seems to debar the use of electricity as a general domestic fuel.

An effective and logical remedy widely applicable consists in the initial carbonisation of the coal whereby the volatile matter is separated from the fixed carbon, as is done in the gas-works. In this way the coal can be resolved into a solid fuel—coke—a liquid fuel—tar (and motor spirit)—and a clean gas, all of which can be burned smokelessly and for most purposes more efficiently than coal. (The tar, though capable of serving as a fuel, has actually a greater value as a source of chemical products.) At the same time ammonia is recovered from the coal. This process of carbonisation, as carried out daily in the gas-works, does not waste the heat of the coal. The table below shows the fate of the heat units in the original coal after being subjected to carbonisation. The figures show the results of a year's working of a typical gas-works, not of the most modern type.

Carbonising Gas Coal in Horizontal Retorts.

Heat of combustion of coal	100·0
Heat content:	
Gas	22·5
Coke sold	48·3
Tar	6·0
	76·8
Heat used and lost in manufacture	23·2
	100·0

The heat units in the total coke made would be higher than the 48·3 per cent. shown, but some of the coke has been used for heating the retorts. Altogether, 23·2 per cent. of the heat of the coal has been used and lost in the process, leaving 76·8 per cent. in the products of carbonisation. This figure is termed the thermal efficiency of carbonisation. With more modern plant 80 per cent. would be a more representative figure. It is interesting to inquire what advantage is gained by carbonisation to compensate for the thermal and monetary cost of the process. From the watery product—ammoniacal liquor—is readily obtained ammonium sulphate, a valuable nitrogenous fertiliser. The tar is the raw material of a great industry. By suitable treatment it furnishes benzene and toluene, which were found so indispensable as the basis of manufacture of high explosives. From them and other tar constituents are derived numerous colouring matters, drugs, and disinfectants. The lighter tar fractions gain increasing importance as motor spirit, and the heavier constituents as a material for the construction of roads suited to the demands of modern traffic. Certain creosote oil fractions are valuable as preservatives of timber, or alternatively may be employed for the propulsion of ships. Coal-tar forms at present our most valuable source of home-produced liquid fuel, and its national importance needs no further emphasis. Clearly there is a considerable creation of value as a result of transforming the resinous constituents of coal into tar instead of allowing them to make smoke in the open grate.

Let us now consider the gas. Here reference must again be made to thermal efficiency, because it is so important in this connexion. The open fire is the most favoured method of heating rooms in our houses, and is, in my opinion, likely to remain so, whatever fuel may emerge in time as being the most satisfactory for burning in it. The peculiar value of radiant heat as thrown out from a fire has been appreciated by generations of our countrymen, and recent physiological work has shown that this peculiar excellence was by no means imaginary, but had a sound scientific foundation. But when we use raw coal in an open fire, we pay a big price—too big a price in many ways—for its cheery blaze.

The inefficiency of the coal fire is best seen when one compares it with the gas fire. For every 100 heat units supplied to a modern gas fire, practically half is radiated into the room, while with a coal fire the radiated heat is less than a quarter of that supplied in the coal. In both these cases there is, of course, a proportion of heat which goes up the chimney. With the coal fire it is inordinately large, but with the gas fire it is reasonable in amount, about one-third of the total. I say it is reasonable in amount because a certain quantity of heat going into the chimney does perform a useful function in ventilating a room; and as the ventilating function of the open fire is probably as important as its heating function, a certain amount of heat may very well be devoted to this purpose. The trouble with the coal fire is that the proportion used in this way is much too large, wasting fuel, and over-ventilating the room to the extent of creating draughts. The gas fire is economical in the way in which it utilises the heat units brought by the gas for the combined purpose of heating and ventilating, which it does in an economical and practically convenient manner. It is sometimes said in extenuation of the very low thermal efficiency of electrical generation that the efficiency of an electrical heating appliance can be taken as 100 per cent. But plainly this can only be the case if no air goes into the chimney hot enough to produce the ventilation which is so essential, and in that case an auxiliary ventilating appliance must or should be provided, with additional cost.

This high efficiency of gas for room heating is typical of what it can do in many other uses, because it is so subject to simple and exact control that apparatus can be designed for burning gas of a much more refined and scientific construction than can be contemplated for the burning of coal. Moreover, not only is gas clean in the ordinary sense, but it also has been purified from nearly all its sulphur compounds at the gas-works, while it has to be remembered that every ton of raw coal which is burned in even the most modern steam-raising plant of a factory or electrical generating station turns out about half a hundredweight of sulphurous acids into the atmosphere. In this respect gas is superior not only to raw coal, but also to the smokeless solid fuels.

Nor is it to be forgotten in these days, when the electric motor has rightly come to occupy such a strong position for the provision of power, that the gas-engine is thermally more efficient than any other type of prime mover in common use, and that Sir Dugald Clerk has expressed the opinion only recently that, where a small isolated unit of power is required, a gas-engine using town gas is still the most economical plant available from both the thermal and the monetary points of view.

The solid smokeless fuel, or coke, resulting from carbonisation, is a subject to which the public attention has been very much directed lately by numerous utterances—æsthetic, hygienic, scientific, technical, and political—displaying very varying degrees of competence and impartiality. It may, however, be taken as agreed that for those domestic purposes where solid fuel continues for any reason to be used, it should be of the smokeless kind. There is no chance of our attaining the ideal of the smokeless city until that principle is applied.

The coke produced by the ordinary gas-works process is a form of solid smokeless fuel which is at the present time produced in large quantities. Other methods have been suggested and are being tried which have been grouped under the heading of low-temperature carbonisation.

Now it is to be remembered that in the earlier days of the gas industry, gas was made in iron retorts, which meant that of necessity lower temperatures were employed than are in common use to-day. The plain fact is that the development of the gas industry has proceeded in the direction of making more gas from the coal; and there is a sound reason for this, because every heat unit secured after the transformation of the carbonisation process in the form of gas is, from every point of view, thermal or monetary, worth so very much more than a heat unit in coal, and this appreciation in value is so much greater in the gas than it is in the tar or the coke.

The changes in gas practice have been in the direction of using higher temperatures, or even of gasifying some of the coke either in the gas retorts or in separate generators. The reversion to low-temperature carbonisation is not easy to justify. The carbonisation process has to be considered as a whole, as one yielding four main products—gas, tar, ammonia, and coke. Merely lowering the temperature gives very much less gas—say, about half. More tar is produced, not of a kind containing benzene or toluene, and more difficult to refine, but probably yielding more motor spirit. The ammonia yield is smaller. The coke is softer, easier of ignition than ordinary gas coke, and burns with more flame, but is more liable to crumble in manufacture and transport.

To counterbalance the loss of the high gas yield does appear to be an exceedingly difficult problem, as is now coming to be realised. I am far from saying that it is insoluble, but it would appear to necessitate either obtaining a very high order of value in the by-products, or of evolving some process of carbonisation very much less costly than has hitherto been used; and neither of these is the easy thing to do which optimistic utterances would suggest.

The production of smokeless solid fuel, however, is not necessarily bound up with low-temperature carbonisation. Low temperature is only one of the factors involved. The transmission of heat through coal during coking, the physical and chemical changes which occur, and the extent to which the carbonisation process can be speeded up and modified by proper preparation of the coal, all require exploration. The gas industry is becoming increasingly alive to the possibilities in this direction, to the necessity for thorough and systematic examination of all the factors operating in the carbonisation process, and an investigation of what can be done, for example, by proper preparation of the coal, which may involve washing, grinding, blending, and briquetting, or even the addition of some inorganic constituent, because, strange though it may seem, the presence of some of the ash constituents, such as oxide of iron, has been shown to exercise a marked influence on the coking process and the nature of the coke produced. The further control of the quality of coke and its supply in a form which is not crumbly, but easily ignited, burning cheerfully and not leaving too much ash, is one of the most interesting things with which the gas industry is now occupied.

I may, however, at this point indicate that undoubtedly the best utilisation of smokeless solid fuel will also be greatly helped by a more careful study of the best construction of grate for burning it, since the grate as at present used has been evolved for the burning of raw coal, the requirements of which are somewhat different. There is little doubt that, if the house grate of to-day was slightly, but suitably, modified in construction, quite a hard coke would burn well in it. As regards the efficiency obtainable from coke, all the tests made by Dr. Margaret Fishenden, on behalf of the Fuel Research Board, indicate that it is appreciably higher than that obtainable from raw coal (which is all to the good), though nothing like so high as that obtainable from a gas fire.

Enough has now been said to indicate clearly that, apart from other considerations such as those of cleanliness and hygiene, the gas industry is entitled to put forward the claim that, on the basis of thermal efficiency alone, its methods of dealing with our coal supplies represent the highest order of actual achievement in the present. What it may be able to do in the future it is not possible for any one of us to foresee. Its problems become more interesting every day, necessarily more complicated, and make more demands upon those engaged in it. But the position of the gas industry is scientifically sound; and by systematic and patient research and trained intelligence applying the results of research to technical and commercial developments, that position can be made even more assured.

Cosmic Rays.

By C. S. Wright.

THE recent address by Prof. Millikan, printed in NATURE of December 5, together with the popular statements in the daily press, have directed attention once more to certain geophysical problems which have received scant attention lately from British investigators Details of Millikan's observations on the top of Mount Whitney are still lacking, but it seems clear that another phase in the investigation may now be regarded as terminated.

The first phase of the investigation opened with the discovery in 1901, independently by C. T. R. Wilson and Geitel, that within a closed vessel there was a continuous production of gaseous ions which rendered the contained gas conducting to a minute extent. This observation was followed by the discovery, by Elster and Geitel, of the existence of radioactive products in the atmosphere which might be responsible for some part at least of the conductivity observed. Observations of the radioactivity of the air or, more correctly, measurements of the ionisation due to the active products collected on a negatively charged wire, led to the certainty that the products were due to the disintegration of radioactive emanations derived from the soil, springs, etc. A systematic investigation of the various types of rock by the present Lord Rayleigh soon yielded representative figures for their radium content, but it was not until 1908 that an accurate value for the mean radium content of the air near the ground (about 10^{-16} gm. per c.c.) was available as the result of the work of Eve, Satterly, and Ashman. These efforts made it clear that the radioactivity of earth, air, and—to a minute extent—water, must all be regarded as possible contributors to the ionisation in closed vessels.

In the meantime another plan of attack was developed in Canada in 1902 by Rutherford and Cooke, and McLennan and Burton, followed by Wright and others. This attack was directed towards localising the source of the penetrating radiation and determining its hardness or penetrability. Screens of lead were used by the first-named investigators, while McLennan and Burton, having found that the local water supply was free from radioactive impurity, surrounded their vessel with layers of water up to 60 cm. thick. Both experiments were successful in reducing the ionisation by about 30 per cent. Rutherford and Cooke increased the amount of lead in their screens to a total weight of 5 tons, but no greater decrease was observed than with a screen thickness of 3 cm. It was also found that the radiation in the basement of the laboratory in Montreal apparently came equally from all directions. In the attempt to reduce the ionisation further, and in the hope of localising its sources, Wright was driven in 1908 to undertake field observations over the surface of Lake Ontario, on frozen lakes, and in a deep tunnel at Niagara Falls. These experiments showed a notable reduction over the water and ice, but no reduction in the tunnel, and enabled an estimate to be made for the contribution of the earth to the measured ionisation. Though later work has thoroughly confirmed the efficacy of the water and ice-screens, an observation on the University tower at Toronto conflicted with observations by von Bergwitz, McLennan and Macallum, and Wulf, all of whom found a decreased ionisation at a height above the earth. This discrepancy may have been due to a local concentration of radioactive material at the place of observation.

In the interval a further line of attack had been opened by the discovery of a daily variation in the penetrating radiation by Campbell and Wood (1907), Strong, and Wulf, though these observations were flatly contradicted by those of Gockel, Wright, and Cline. This contradiction was later recognised as due to local variations in the relative importance of the different sources of ionisation. It was indeed not until 1909 that the relative importance of these various sources was realised with any certainty, and particularly the part played by that source which was chiefly responsible for the local daily variation in the penetrating radiation. This source was a surface deposit of radioactive materials derived from the air and resulting from radioactive emanations coming from the soil. These active materials are continually being deposited on the earth's surface at a rate dependent both on the varying value of the earth's potential field and upon the amount of active material in the atmosphere, while the normal rates of decay of the radioactive substances while in the air and on the ground set a limit to their accumulation.

This phase of the investigation may be regarded as closing with the determination in 1910 by Simpson and Wright, during the course of Capt. Scott's last Antarctic expedition, of the contribution to the ionisation by the radioactive surface deposit on the ship after immersion in land-derived breezes of measured radioactivity. The slow rate of decay of the ionisation, after the return to normal sea conditions of low-air activity, indicated the presence of thorium as well as radium products on the ship's structure. The absence of a daily variation during the voyage was clearly due to the continuous low activity of the ocean breezes.

These data, and those obtained by many others on land, showed that the chief recognised sources of penetrating radiation were the active surface deposit, radioactive substances in the earth, and active products derived from emanations which might enter the ionisation vessel if steps were not taken to exclude them. The effect of radioactive materials in sea-water, or ice, beneath, and in the atmosphere round and above, the place of observation were recognised as inappreciable. Even under the most favourable conditions, however, there remained still an ionisation about half as great as the minimum land value, and the source of this residual ionisation was still unknown at this date. Possibly the view that the residual effect was due to a slight radioactivity of all materials was the most popular one. One of the earliest investigations had, in fact, arisen from the discovery of lead as the end-product of the radium transformations, which led McLennan and others to the observation that the substance of the ionisation chamber, *e.g.* lead, may contribute notably to the conductivity. Though some samples of lead were clearly radioactive, no definite conclusion was reached on the question whether all substances were radioactive in some degree, or whether the differences with different metals were due to a secondary radiation from the walls of the container.

The second phase of the investigation may be said to commence with the initiation of measurements in balloons by Gockel and later by Hess, who established the fact that, during an ascent, there was first a decrease, and later an increase, in the measured ionisation. To explain this increase, Hess assumed the existence of a "sehr durchdringende Strahlung ausserterrestrischen Ursprungs," which was responsible even for a portion of the ionisation at sea-level. A similar increase with height was observed in balloon ascents over the sea. This work was continued by Kohlhörster during 1913 and 1914, with improved apparatus, the balloons ascending in one case to a height of 9 km., and an attempt was made to calculate the absorption coefficient of the radiation from the relation between height and ionisation. These results indicated, on the assumption that the radiation was directed vertically downward, that the hardness of these rays was about six times as great as the hardest known γ-rays. Radiation of this hardness would be able to penetrate through the atmosphere to sea-level in measurable amount. These results were confirmed by numerous German observations made on mountain tops. Kohlhörster,[1] in his 1923 paper, calculated the absorption coefficient of the cosmic rays from the later balloon observations and from screening experiments in water and in glacier ice. The absorption coefficients so obtained showed considerable consistency, and the average value was given as $\mu\,(\text{water}) = 2{\cdot}5 \times 10^{-3}$, *i.e.* the rays were found to be more penetrating even than the first upper-air observations showed. This absorption coefficient compares with $\mu\,(\text{water}) = 3{\cdot}9 \times 10^{-2}$ and $3{\cdot}3 \times 10^{-2}$ for the hard γ-rays of radium C and thorium D.

In the same paper, Kohlhörster discusses the source of the cosmic rays in the light of a variation observed by him during the day in a glacier crevasse, and even under 4·5 metres of glacier ice. He tentatively ascribed the variations to the changing orientation of the crevasse with respect to sources in the neighbourhood of the Milky Way. In fact, the tentative conclusion was in favour of an origin such as the red giant stars or nebulæ.

In the absence of detailed results, the observations of Millikan seem to confirm and also to extend those of Kohlhörster, though there is one point at least on which there is some disagreement. In addition to giving a new figure for the absorption coefficient—$\mu\,(\text{water}) = 1{\cdot}8 \times 10^{-3}$—corresponding to a greater hardness even than was thought, Millikan adds that the rays extend throughout a spectral region from 0·0004 Å.U. to 0·00067 Å.U., and that the secondary rays from the cosmic radiation show the Compton effect. From the wording of Prof. Millikan's address it seems that he has measured the difference in wave-length between the primary and secondary scattered rays. He states that the cosmic rays come into the earth with equal intensity at all hours of the day and with practically the same intensity in all directions. It is this conclusion which appears to be in disagreement with Kohlhörster's results, though it is true that the daily variation observed by the latter was not pronounced.

The minimum wave-length of the cosmic radiation quoted by Millikan is only $\frac{1}{10}$ that of the hardest known γ-rays of radioactive type, the wave-length being in fact of the order of the distance over which the positive charge of the atomic nucleus behaves as if it were a point charge. It is therefore difficult, as Millikan points out, to escape the conclusion that the rays arise from transformations actually in the nuclei of atoms. As to the origin of the cosmic rays, it is difficult to consider the possibility of their initiation except in certain portions of space where the existence of atoms stripped of all their electrons may be suspected, and where absorption of the rays near the source will not be excessive Some such considerations doubtless led Nernst to the view that the origin of the very penetrating radiation might lie in the nebulæ of low density.

The scattered radiation will, by virtue of the Compton effect noted by Millikan, bridge the gap between the cosmic rays and the gamma-rays from radioactive substances, but unless a method of producing these rays in the laboratory can be developed, the only possibility of experimenting effectively with them will be by observations at high altitudes. Lest it should be thought that these rays might fulfil the function of the "ultra-X" rays which Perrin has postulated as the possible cause of radioactive transformations, it is well to point out that early measurements of the ionisation in closed vessels in tunnels and in deep caves gave values which were sometimes as large as those made on the earth's surface above. As these results could only have been due to radioactivity of the rock forming the cave, it is clear that Perrin's postulate is not in any way rendered more probable by the existence of rays of the hardness noted.

While we may consider Millikan's fine achievement as terminating the second phase of the investigation, it seems certain that there are other developments to follow. It is possible that there is still some ionisation in closed vessels which is not accounted for, and for which a separate cause must be found. The lowest values obtained in a metal vessel over the sea correspond to the production of about 4 pairs of ions per c.c. per sec. Of this number, between one and two pairs seem to be due, directly and indirectly, to the cosmic rays. According to Kohlhörster the ionisation is greater by the production of 4, 9, and 17 pairs of ions at heights of 3, 4, and 5 km. above sea-level. A contribution of about 2 pairs may result from the surface deposit of radioactive materials on a small ship such as the *Terra Nova*, this being derived originally from land sources. An addition of 6 pairs or more is to be expected in land observations, in part due to radioactivity of the soil and in part to additional radioactive deposits on neighbouring surfaces. The effect of this deposit is equivalent to about 0·5 gm. of radium per sq. mile, on the average. The amount of this land contribution will of course vary with the site of the measurements, and one is probably not far wrong in estimating that, on the average, the land effect is due about equally to the two sources stated. An exceptionally low value of 2 6 pairs of ions was obtained by McLennan and Murray over Lake Ontario, using an ionisation chamber of ice, while observations in an ice cave on the shores of the Antarctic Continent gave a minimum value of 3 pairs, though too much reliance must not be placed on this figure. It is, however, known that the air radioactivity in this place is only slightly greater than over the ocean. Any residual ionisation which has not been accounted for is therefore minute in amount. The final results of Prof. Millikan's observations may settle this point, but the very slightest trace of radioactive impurity in or on the walls of the vessel would cause an ionisation sufficient easily to account for any difference. Measurements in a metal chamber under varying high pressures is one investigation which would probably give useful information on the residual effect, if made in a submerged submarine in order to exclude the cosmic rays.

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[1] *Sitzungsber. d. Preuss. Akad. der Wiss.*, 34, 1923.

Though the ionisation currents dealt with in work on penetrating radiation are small—of the order 10^{-14} to 10^{-15} ampere—the measurements can be made with considerable accuracy, so that there is no possibility for doubt as to the reality of the existence of the cosmic rays. It is, however, a matter for regret that laboratory experiments on the properties of these rays cannot be carried out effectively in Great Britain, since it is only at great altitudes that the cosmic rays contribute more than a fraction of the total ionisation. The possibility of the discovery of a laboratory source of these rays must be regarded as remote, though it is unwise to be dogmatic even on this point.

Mineral Production in India.[1]

AMONG the many useful services rendered by the Geological Survey of India must be reckoned the issue of a Quinquennial Review of the Mineral Production, initiated during the directorship of Sir Thomas Holland. The first of these reviews appeared in 1905 (*Rec. Geol. Surv. India*, Vol. 32, Part I.), and covered the period 1898–1903. Since then, four others have been published, the latest, covering the period 1919–23, being a voluminous and interesting account of the progress during the period, contributed by the director (E. H. Pascoe) and the senior officers of the Survey, including L. L. Fermor, J. Coggin Brown, H. C. Jones, C. S. Fox, and W. A. K. Christie.

The average annual value of the output in India of minerals for which trustworthy returns of production are available, during the five years 1919–23 inclusive, was as follows:

	l.
Coal	9,252,649
Petroleum	7,036,298
Gold	2,094,323
Manganese ore	1,995,341
Salt	948,245
Lead and lead ore	881,710
Silver	642,450
Mica	633,331
Saltpetre	355,118
Tin and tin ore	214,500
Tungsten ore	135,845
Iron ore	114,956
Jadestone	114,329
Ruby, sapphire and spinel	60,660
Chromite	53,764
Monazite	29,294
Copper ore	29,053
Magnesite	16,334
Diamonds	7,262
Graphite	265
Total value	24,615,727

Of the countries in the British Empire, India stands second as regards coal output, being well ahead of the Union of South Africa, Canada, and Australia, although the output of rather more than twenty-one million tons in 1924 amounted to less than 8 per cent. of the output of Great Britain. Of the Indian output, more than 98 per cent. was from Gondwana coalfields, including 52 per cent. from the Jharia field and 28 from the Raniganj. The Bokaro field, with 4·7 per cent. of the output, is now ahead of the output of the Giridih and Singareni fields. It is expected that the Bokaro will before many years prove to be one of the great coalfields of India. Coal exports during the period ranged from a maximum of 1¼ million tons in 1920 to a minimum of 77,000 tons in 1922. In its coal export trade to ports in the Indian Ocean, India has to compete with Japan and South Africa, both of which countries are regarded as formidable rivals in this trade. The employment of by-product ovens in coke-making has of late been considerably extended, as also has the employment of electrical energy in mines for pumping, etc.

The large increase in annual value of the petroleum output from an average of 1,073,604*l.* during the period 1914–18, to an average of 7,036,298*l.* for the period under review, does not indicate a corresponding increase in the actual output, which averaged 282,594,121 gallons annually during the former period as compared with 299,453,675 during the latter period. The large increase in value referred to is attributed chiefly to the fact that the value of petroleum during the former period was much under-estimated, and partly to the high exchange value of the Indian currency in 1919 and 1920, during which years there was an increased output. The director of the Geological Survey thinks the chances are that the next five years will show a smaller increase of output than was shown by the last five years, and possibly even a decrease. India still contributes only a very small part of the world's supply of petroleum, the output for 1923 being only 0·83 per cent. of the world's marketed production.

The period was one of substantial progress for the iron and steel industry in India, which was in a declining condition at the outset of the quinquennium. In spite of this progress, however, a Tariff Board was appointed recently to inquire into the question of protection for the steel-making industry. As a result of its inquiry the Tariff Board concluded that, without some form of protection, the Indian steel industry would certainly not develop for many years, and might even cease to exist. Following the Board's recommendations, the Legislative Assembly quite recently (September 1925) agreed to a grant of a maximum of

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[1] *Records of the Geological Survey of India.* Vol. 57: Quinquennial Review of the Mineral Production of India for the Years 1919 to 1923. By the Director and Senior Officers of the Geological Survey of India. Pp. viii+398+lxxi+5 plates. (Calcutta: Government of India Central Publication Branch, 1925.) 5 10 rupees; 9s. 9d.

60 lakhs of rupees to the steel industry up to March 1927, after which date, when the Protection Act expires, the question will be reconsidered.

India assumed leadership in the production of manganese ore so early as 1907, and, after a relapse in the years 1912–15, regained it during the War period, in spite of much competition from Brazil. The report states, however, that discoveries of new and valuable deposits of manganese ore seem to have ceased, and that the period under review has been marked by stability in this section of the mining industry, accompanied by gradual development of some deposits and exhaustion of others. The average annual output of manganese ore for the period was 624,635 tons, compared with 577,457 tons in 1914–18, and 712,797 tons in 1909–13.

The output of chromite (chromium ore), which had increased substantially during the War period, continued to increase during the period under review, the average annual output being 35,000 tons as compared with an average of 23,000 tons for the previous quinquennium. The increase was due chiefly to greater activity in the chrome mines of Baluchistan.

The output of tungsten ore in Burma, which had increased greatly during the War period, having reached 4542 tons in 1917, dwindled during the period under review to an output of 872 tons in 1923. The tin output, on the contrary, showed an increase to an average annual of 138 tons (metal) compared with an average of 116 tons for the preceding quinquennium.

The gold-mining industry of India suffered during the War period, during which the average production was a little less than 587,000 ounces annually. The decline in output has continued steadily through the period under review, during which the average was 459,875 ounces.

Further marked progress is reported in the output of the lead-silver-zinc mines at Bawdwin and Namtu in Burma. The output of lead extracted from the ore at these mines rose steadily from 19,000 tons in 1919 to 46,000 in 1923, while that of silver increased from more than two million ounces in 1919 to about five million ounces in 1923.

India is the leading producer of mica of good quality. We learn, moreover, from this report that the art of producing fine splittings of mica by hand is practised more efficiently in India than in other countries, so much so that during recent years India has imported mica for conversion into fine splittings for export. India also holds a monopoly in shellac production, which gives her power to control the production of micanite if necessary.

The average annual output of magnesite, chiefly from the deposits at Salem in Madras, increased by 77 per cent. in the period under review.

There was no progress in the jadeite industry during the period dealt with. The average annual exports amounted to 4628 cwt. as compared with 4651 cwt. during the previous quinquennium, but the value was much higher.

The output of monazite declined substantially during the period 1919–23, having fallen from 2000 tons in 1919 to only 125 tons in 1922.

The output of bauxite during the period continued low, averaging 5220 tons annually. The returns for 1924, however, show an increase to 23,228 tons of bauxite, from 6547 tons in 1923. By far the larger part of the 1924 production was from the Kaira district, in the Bombay Presidency.

Among new and interesting features in the mineral production of India, mention may be made of ilmenite, zircon, sillimanite, and kyanite. Ilmenite and zircon occur with monazite in the beach sands of Travancore, and are obtained as by-products in the magnetic concentration of the monazite. The outputs of ilmenite for 1922, 1923, and 1924 were 400, 700, and 641 tons respectively, while those of zircon were 160, 145, and 365 tons respectively.

Sillimanite has in recent years come into prominence as a refractory, and much interest has been taken in the deposit of the Khasi Hills, Assam, which was formerly thought to be one of corundum. Four outcrops of sillimanite have been found, but the extent of the deposit is not known. The quantity of boulders, etc., at the surface is stated to amount to about 3000 tons. No sillimanite appears in the production statistics of 1923 and 1924.

A discovery of kyanite was made in the Lopso Hill area, Kharsawan State, Singhbhum, in 1921. Analyses show the rock to consist of practically pure aluminium silicate, and experiments show that it is suitable for use as a refractory. Several hundred tons have been sent to England, and it is thought that a demand for it as a refractory may arise. An output of 224 tons of kyanite is reported in the production statistics of the Geological Survey for 1924.

T. C.

Obituary.

MR. J. H. MAIDEN, I.S.O., F.R.S.

ON November 16, at his residence, Turramurra, Sydney, the death occurred of Joseph Henry Maiden, who in 1924 retired from the position of Director of the Sydney Botanic Gardens and Officer-in-Charge of the Centennial Park. Mr. Maiden was born at St. John's Wood, London, on April 25, 1859, and received his early education at the City of London Middle Class School. He soon showed a taste for science, and for some time was assistant to the late Prof. F. Barff. He came to Australia in 1880, for health reasons, having provided himself with a return ticket, but the climate proved so beneficial that he decided to remain, and became associated with the formation of the Technological Museum, Sydney, of which he was Curator from 1881 until 1896, and he soon began to study the native plants. Some of his early botanical lessons were learnt from the late Rev. Dr. William Woolls, of whom he always retained the most affectionate memories. He was also a colleague in botanical work of the late Baron von Mueller in his latter days, another of the great pioneers of Australian botany. Mr. Maiden was Superintendent of Technical Education from 1894 until 1896; Consulting Botanist to the Departments of Agriculture and Forests from 1890; Director of the Botanic Gardens, Sydney; and Government Botanist from 1896 until his retirement in 1924.

The particular genus which Mr. Maiden studied most intensively was that almost exclusively Australian one —Eucalyptus—and he added very many new species to the list previously known, his field of investigation extending all over Australia. By his enthusiasm and energy he formed the present Herbarium at the Sydney Botanic Gardens, one of the finest in the southern hemisphere, and made many personal journeys in the various States for material to enrich his collections. He also, at considerable trouble, obtained type specimens which were collected in Australia in the early days, but had been housed in herbaria in other parts of the world, including some collected by Sir Joseph Banks in 1770.

Perhaps Mr. Maiden's greatest work in the field of botanical research is his "Critical Revision of the Genus Eucalyptus," of which sixty-four parts have already appeared and others are going through the press. Another valuable publication is the "Forest Flora of New South Wales," of which seventy-seven parts have been issued. Other publications included "Illustrated Flowering Plants and Ferns of New South Wales" and "Useful Native Plants of Australia." He made numerous contributions on various subjects to the *Agricultural Gazette of New South Wales*, and the service he has rendered in the interest of forestry in this State has been very great.

Mr. Maiden was honorary secretary of the Royal Society of New South Wales for twenty-two years, and president in 1896 and 1911; president of the New South Wales Horticultural Society for twenty years and of the Horticultural Association for eighteen years, as well as president of the Linnean Society of New South Wales and the Royal Australian Historical Society, in each case for two years. He was a man full of energy, and one of the most outstanding features of his activities was his industry. He never seemed to tire of writing up and placing on record any scientific facts which made for the advancement of knowledge, his contribution to the Royal Society of New South Wales being forty-five papers, the last having been presented in 1925, while his papers to the Linnean Society of New South Wales amounted to ninety-five. He entertained a very high regard for Sir Joseph Banks, whom he styled "The Father of Australia," and his biography of Sir Joseph, written chiefly for the purpose of raising funds for a memorial to that great botanist, is considered to be a classic. Mr. Maiden was one of the chief originators of the National Wattle Day Celebration in the Commonwealth, which has for its object the cultivation of an Australian national sentiment, while keeping in view that this country forms part of the British Empire.

In 1915 Mr. Maiden was awarded the Linnean Medal by the Linnean Society of London, this being the first occasion upon which this medal had been won by an Australian. He was elected a fellow of the Linnean Society in 1888, and in 1916 was honoured by having the Imperial Service Order conferred upon him, and also by being elected a fellow of the Royal Society. In 1921 he was offered the presidency of the Australasian Association for the Advancement of Science, but declined it for health reasons, and in 1922 was awarded the Mueller Medal by that body, of which he was honorary secretary for fourteen years; in 1924 he gained the Clarke Memorial Medal awarded by the Royal Society of New South Wales.

Mr. Maiden ranks among the half-dozen leading pioneering botanists who have contributed so much to our knowledge of the unique Australian flora, and for many years was regarded as the doyen of Australian botanists. He served as an inspiration to very many science students, probably more than ever will be known, and as some evidence of the affection and esteem in which he was held by his colleagues in science he was, in 1916, presented with his portrait in oils. In addition to the amount of scientific work which he carried out as the result of his own investigations, he was an outstanding benefactor to scientific progress generally, and being a born organiser added great strength to those societies which were reached by his influence. Truly it may be said of him that he left the world richer for his labours, and his life was filled with greatness, nobility and sincerity.

R. H. CAMBAGE.

WE regret to learn from the *Chemiker-Zeitung* of the death of Dr. Erich Krause, director of the laboratories of the Wood Carbonisation Co. of Constance. Krause was born at Weissenfels and educated at Leipzig and Vienna. At Vienna he became assistant to Prof. Skraup, in conjunction with whom much of his original work was published. The researches were partly in organic chemistry and partly in physical chemistry and were concerned mainly with the investigation of proteins. In 1911 he entered the service of the Holzverkohlungs-Industrie, when he devoted his energies to the perfection of analytical methods, his main results being published in the new edition of the well-known work of J. König, "Die Untersuchung landwirtschaftlich und gewerblich wichtiger Stoffe." In collaboration with his colleagues he worked out a process for obtaining methyl alcohol from natural gas. During the War, Krause devoted much time and attention to the problem of finding food-substitutes.

WE regret to announce the following deaths:

Dame Louisa Aldrich-Blake, D.B.E., Dean of the London (Royal Free Hospital) School of Medicine for Women, one of the first among medical women to practise general surgery, on December 28, aged sixty years.

Prof. Matthew Curry, formerly professor of engineering at King's College, London, on December 29, aged seventy-four years.

Dr. C. Gessard, of the Institut Pasteur, Paris, who isolated a pyocyanic bacillus from pus in 1882, and was also known for his work on oxydases and on bacteria generally.

Dr. J. G. M'Kendrick, F.R.S., emeritus professor of physiology in the University of Glasgow, on January 2, aged eighty-four years.

Prof. Alfred Perot, professor of physics in the École Polytechnique, Paris, and president of the Commission de Métrologie, on November 27, aged sixty-two years.

Sir R. Douglas Powell, Bart., K.C.V.O., physician in ordinary to the King, president of the Royal College of Physicians in 1905-10, and formerly president of the Royal Medical and Chirurgical, the Clinical and Medical Societies, on December 15, aged eighty-three years.

News and Views.

The list of New Year honours includes the following names of men of science and others associated with scientific work:—*Privy Councillor*: Lord Bledisloe, Parliamentary Secretary to the Ministry of Agriculture and Fisheries. *Baronets*: Mr. W. W. Butler, member of Council, University of Birmingham, and Sir Robert Jones, president of the Association of Surgeons of Great Britain. *Knight Commander of the Order of St. Michael and St. George* (*K.C.M.G.*): Prof. M. W. MacCallum, vice-chancellor of the University of Sydney. *Knights*: Prof. T. Hudson Beare, Regius professor of engineering, University of Edinburgh; Dr. R. A. Bolam, chairman of council, British Medical Association; Prof. J. B. Farmer, professor of botany, Imperial College of Science, South Kensington; Major A. McN. Cooper-Key, chief inspector of explosives, Home Office; and Mr. P. J. Hartog, vice-chancellor of the University of Dacca. *Companion of the Order of the Bath* (*C.B.*) (*Civil Division*): Mr. Arthur H. Smith, late Keeper of Greek and Roman Antiquities, British Museum. *Companion of the Order of the Indian Empire* (*C.I.E.*): Lieut.-Col. J. W. D. Megaw, director of the School of Tropical Medicine and Hygiene, Calcutta.

The New South Wales Government has announced its decision to close the State Observatory, which for many years has been under the control of Prof. W. E. Cooke. Owing to the growth of Sydney, the site of the Observatory has become quite unsatisfactory and its work has suffered in consequence. The necessity for removal to a distant suburb has repeatedly been urged upon successive State Governments; but the Labour Ministry's method of dealing with the problem has come as a distinct surprise. It is unlikely that this abrupt decision will mean withdrawal of governmental support of astronomical work in New South Wales, and it may serve a very useful purpose in focussing attention upon, and possibly leading to a settlement of, the question as to whether the individual States, or the Commonwealth, should take charge of such work. Some years ago the Commonwealth accepted sole responsibility for meteorological services, and the consequent co-ordination of effort has had highly satisfactory results. The establishment of the Commonwealth Solar Observatory at Mount Stromlo, Canberra, has already provided a precedent for the entry of the major Government into astronomical work, and there are many people who strongly favour its assumption of control over all the Observatories. The New South Wales decision will not take effect immediately, and in the meantime the whole situation, as it affects all the States, will be given most careful attention. Possibly this apparently hostile act on the part of a State government may prove, in the end, to be a blessing to astronomy in Australia.

It is only a year or two ago since G. F. and G. M. Dick in the United States described an intracutaneous immunity test for scarlet fever. They used a soluble toxin elaborated by a blood-destroying streptococcus microbe which was isolated from cases of scarlet fever, and they developed a new theory of this eruptive fever, namely, that it was really a localised disease of the throat caused by a specific streptococcus producing a toxin which, on absorption into the blood stream, gave rise to constitutional symptoms associated with a characteristic rash. Already the "Dick test" has been applied to enormous numbers of people especially in the United States, and it is now coming into prominence in the English medical Press. The *Lancet* of Dec. 26 contains three papers on the subject by Drs. Joe, of Edinburgh, Silcock, of Leicester, and O'Brien and Okell, of the Wellcome Research Laboratories. The paper of the last workers, entitled "Some Problems connected with the Dick Test," is particularly interesting, dealing as it does with the difficulties of the test and the real significance of negative and positive reactions as measures of the immunity in scarlet fever. It is known, broadly, that a negative response indicates a high degree of non-susceptibility to the disease, but Drs. O'Brien and Okell are not equally certain that a "positive" and particularly a "partial positive" reaction may not indicate some immunity. They also tentatively touch the question whether there may not be immunologically distinct types of the disease as occur in other well-known bacterial infections. Already there are some indications that the so-called streptococcus of scarlet fever may not be so specifically distinct as was believed a year back.

The rapid progress that is being made by telephony is proved by the statistics published in *Electrical Communication* last October by the International Standard Electric Corporation of New York. The problem of giving telephone service becomes more complicated every day. Every new subscriber makes the problem more difficult. In 1905 there were 300,000 telephone sets in operation in the New York metropolitan area. There are now 1,900,000, and it is estimated that by 1945 there will be at least four millions. The number of telephone stations at present is 130, 26 having been added during the last year. Some of these are enormous buildings serving 100,000 subscribers, and very costly to erect. The introduction of automatic switching adds considerably to the complexity of the problem. In the United States and Canada the number of telephones for each hundred inhabitants in 1924 was 13·7 and 11 respectively. In Europe, Denmark heads the list with 8·7, Sweden comes next with 6·7, and Norway third with 6·1. Germany has 3·8, Great Britain and North Ireland 2·5, and France 1·5. Curiously Great Britain, Germany, and Switzerland have almost exactly the same number of miles of telephone wire per inhabitant. The number of telegrams per inhabitant in all countries is only a small fraction of the number of telephone conversations. In the United States, Denmark, and Sweden the fraction was less than one-hundredth in 1923, and in Great Britain and France it was less than one-twentieth. Long-distance telephony is making very satisfactory progress in the United States. The Chicago-New York cable which was started in 1918 is practically completed. One of the most serious difficulties that had to be overcome was the effect produced by the changes of temperature occurring every twenty-four hours. This produced a thousand-fold difference in the amount of electrical energy received over the line from the same input. Automatic regulators are employed which vary the amplification introduced by the thermionic valve repeaters with the temperature of the cable conductors.

LIEUT.-COL. THE HON. CUTHBERT JAMES, president of the College of Pestology (Incorporated), sends us a long letter upon the steps which led to the conversion of the Incorporated Vermin Repression Society into the College, and the character and work of this institution, by way of comment upon the note which appeared in NATURE of December 12, p. 875, referring to a public appeal for twenty thousand pounds to establish a memorial to the late Prof. Maxwell Lefroy. We pointed out that the college had no connexion with the University of London and suggested that any memorial would be more appropriately associated with the Imperial College of Science, where Prof. Lefroy was professor of entomology, than with such a propagandist organisation as that of which Lieut.-Col. James is president. We do not doubt that, as he remarks, " so far as it lies in the power of the College to make it so, its affairs are arranged strictly according to Cocker," but the fact that the authorities of the Imperial College refused to take part in the meeting called by the College of Pestology to arrange for the proposed memorial is in itself sufficient to show their attitude towards the originators of the appeal and their intentions. Lieut.-Col. James informs us that his appeal committee would welcome the addition of Prof. Lefroy's scientific colleagues as members, and we are glad to make his invitation known to them and any others who may wish to support a movement to obtain by public subscription the sum of twenty thousand pounds for " a chair and centre of applied biology at the College of Pestology, Bedford Square."

A DISCUSSION was opened at the Institute of Actuaries at the end of October by Mr. F. A. A. Menzler with the hope of indicating extensions of the work of the actuarial profession. He suggested that the application of statistical methods in business may afford a useful opening for any one who has been trained to examine statistics scientifically. Unfortunately, he discounted his advocacy by saying that there is no need to know about correlation and by implying that, while the mathematics of correlation are frightening, the subject of sampling is easy. Modern work on small samples demands as much hard thinking on mathematical lines as correlation, and it seems strange that any one should approach the matter in Mr. Menzler's way before a body which has not only published a text-book dealing partly with correlation, but also examines to some extent on the subject. Apart, however, from the lack of accuracy in some of the views expressed about modern statistical methods, there is a strong case to be made for the use of all scientific machinery in practical work, and an inefficient or out-of-date instrument is as unwise in statistics as in anything else, as is indicated in the leading article of this issue. Nobody would employ any one but a trained chemist to do chemical analysis, but many concerns will hand over statistical analysis to any one who may be on the staff instead of employing someone really qualified to do the work. Our leading article (p. 37) indicates some aspects of the subject which merit the earnest consideration of scientific workers and business men.

AT the December meeting of the American Geographical Society, the following awards were announced:—The David Livingstone Centenary Medal for 1925 to Luis Riso Patrón, Director of the Oficina de Límites of Chile, for " scientific achievement in the field of geography of the southern hemisphere," in recognition of his contributions to Chilean cartography; Señor Patrón headed the first Chilean Commission to make a precise survey of the Cordillera of the Andes, and as director of the Oficina de Mensura de Tierras he was responsible for the great map of Chile on a scale of 1 : 500,000; the David Livingstone Centenary Medal for 1926 to Erich von Drygalski, of the University of Munich, for his work in the South Polar regions; Dr. von Drygalski carried out notable glaciological and other investigations in the Arctic as leader of the Greenland Expedition of the Berlin Geographical Society (1891–1893) and of the German Antarctic Expedition of 1900–1903. A Charles P. Daly Medal for 1925 to Brigadier-General David L. Brainard, in recognition of his achievements on the Lady Franklin Bay Expedition under Greely in 1881–1884; a Charles P. Daly Medal for 1925 to Captain Robert A. Bartlett, for his services to Arctic exploration; as commander of the *Roosevelt* (1905–1909) he took a leading part in Peary's expedition to the Pole; on the Canadian Arctic Expedition of 1913–1918 he commanded the *Karluk*, and in 1917, under his able seamanship, the Third Crocker Land Relief Expedition achieved success. A Cullum Geographical Medal for 1925 to Pedro C. Sanchez, Director of the Central Mexican Bureau of Geography and Climatology, in recognition of his contributions to Mexican cartography; he has been in charge of the geodetic service of Mexico since 1912; a Cullum Geographical Medal for 1925 to Harvey C. Hayes, research physicist of the United States Navy, for his invention of the sonic depth finder; a Cullum Geographical Medal for 1925 to Lucien Gallois, of the University of Paris, for his work in the advancement of geography; by notable contributions to the history of geography, and by his interpretation of the spirit of geographical science, he has extended his influence far beyond the bounds of France.

LECTURING on " Primitive Transport " at the Edinburgh and Lothians Branch of the Royal Anthropological Institute on December 15, Mr. K. G. Fenelon said that transport methods were developed in early times and among primitive peoples, and unusual modes of locomotion are frequently to be explained by the circumstances of the time or by the nature of the materials available. Thus the passenger- and goods-carrying wheel-barrow of the Chinese has its *raison d'être* in the narrow causeway raised in the middle of bad roads, canoes in the Arctic are naturally constructed of animal products, while in other parts vegetable materials are more usually employed. The beginnings of commercial intercourse between nations or peoples were generally by land. Primitive peoples living on islands, as those in the Pacific, may develop a considerable technique of canoe-building for purposes of war or trading. In such areas, however, the natural conditions have concentrated transport development along that line of progress to the exclusion of others. Man is undoubtedly the most primitive means of transport. The next stage of development is marked by the introduction of the pack animal. The earliest forms of vehicle would appear to be the slide-car or sledge. Though the origin of the cart is lost in antiquity, there seems to be little to object to in the usual theoretical explanation that it arose from the slide-car, the stages in transition being the use of log rollers, solid drum wheels, built-up drum wheels and the spoked wheel. The simplest types of canoes are improvised from solid tree-trunks. The next stage is the dug-out canoe, planks being often added to give a greater height above water level. Bark, wicker and skins are also utilised. The outrigger canoe may have been evolved from rafts raised on floats. The sail is widely distributed, though curiously enough it seems to have been little known among the natives of North and South America.

THE *Kew Bulletin* announces that Mr. C. C. Calder, Curator of the Herbarium of the Royal Botanic Garden, Calcutta, has been appointed Director of the Botanical Survey of India and Superintendent of the Royal Botanic Garden, Calcutta, and of Cinchona Cultivation in Bengal.

PROF. F. P. SLATER, formerly head of the Physical Laboratory in the Experimental Department of the Fine Cotton Spinners and Doublers Association, Ltd., and lately professor of textiles in the University of Manchester, has been appointed chief of the Experimental Department of the Association in succession to Dr. W. Laurence Balls.

THE Ministry of Agriculture and Fisheries has re-imposed, starting on January 1, the admission fee of one penny—on other than students' days—to the Royal Botanic Gardens, Kew, which was abolished in April 1924, and previously yielded a revenue of about 5000*l*. per annum. The present admission fee of 6d. on students' days (Tuesdays and Fridays) will continue to be charged.

DR. G. CLARIDGE DRUCE was elected a corresponding member of the Société Botanique de Genève at the recent jubilee celebrations. Dr. Druce has just completed his account of the botany of Huntingdonshire in the "Victoria History of the Counties of England," which treats of about 800 species; he has already completed accounts of the botany of the counties of Berks, Bucks, Oxford and Northampton for this work.

A CONFERENCE on "The Growing of Lucerne" will be held at the Rothamsted Experimental Station on Wednesday, January 27, at 11.30 A.M. The chair will be taken by the Right Hon. Lord Clinton, and the speakers will include Sir E. J. Russell, Prof. R. G. Stapledon, Mr. J. Mackintosh, Mr. A. Cunningham and Mr. H. G. Thornton. Those intending to be present should notify the Secretary, Rothamsted Experimental Station, Harpenden.

THE French Government has conferred upon Sir Robert Hadfield, Bart., the Cross of an Officer of the Legion of Honour, in recognition of his noteworthy contributions to our knowledge of metallurgy. Sir Robert was elected a corresponding member of the Paris Academy of Sciences in 1923, and recently presented a paper to the Congress of Industrial Chemistry organised in Paris by the French Society of Chemical Industry, in which he showed the great debt which metallurgy owes to French scientific workers.

THE Dyers' Research Medal for 1924–25, offered by the Society of Dyers and Colourists, has been awarded to Dr. F. M. Rowe for the paper entitled "The Identification of Insoluble Azo Colours on the Fibre and of Azo Pigments in Substance," which was published in the July 1924 issue of the Society's journal, and a Certificate awarded to the co-author, Miss Clara Levin. The Medal is offered each year by the Company for the best scientific research or technical investigation connected with the art of dyeing submitted to the Society for publication in its journal.

PROF. DAYTON C. MILLER, professor of physics in the Case School of Applied Science, Cleveland, Ohio, has been awarded the American Association Prize of 1000 dollars for his paper on "The Michelson-Morley Ether-Drift Experiment, its History and Significance," delivered at the recent Kansas City meeting of the Association. The Prize, which was founded by a member of the Association shortly before the Cincinnati meeting in 1923, is given annually for "some noteworthy contribution to scientific advancement presented at the meeting" of the Association.

THE Carnegie Trust of the United Kingdom has generously come to the assistance of the Geographical Association with a gift of 1000*l*. towards equipping the Library of the Association, especially in the matter of sets of foreign periodicals. The Carnegie Trust is specially interested in assisting isolated students and has organised the Central Library for Students, Galen Place, W.C.1, with this in view. The Library of the Geographical Association will henceforth be affiliated to that Library, and the Association hopes that its usefulness to teachers and students all over Great Britain may be thereby increased.

A MODERATELY strong earthquake was felt about 12.30 P.M. on December 23 in the island of Mull and the district around Oban. The shock lasted about five seconds and was accompanied by the usual rumbling noise. The earthquake seems to have originated in or near the same centre as the Oban earthquakes of November 28, 1880, and January 17, 1907, which disturbed areas of about 50,000 and 3100 square miles respectively, the former being felt over nearly all Scotland and in the north-eastern counties of Ireland If the tremor observed at Bothwell at about 12.35 P.M and in Glasgow should prove to be connected with it, the shock was probably rather stronger than that of 1907. So far as known, no damage was caused by the earthquake.

THE sixth International Ornithological Congress will be held at Copenhagen on May 24-29 under the presidency of Dr E Hartert, of the Zoological Museum, Tring The work of the Congress will be divided into five sections dealing respectively with. (1) Systematic ornithology, geographical distribution, palæontology; (2) anatomy, physiology, heredity and evolution, (3) biology, including ecology and bird migration, (4) oology, nidification, (5) bird protection and aviculture The executive committee of the Congress includes representatives of Denmark, France, Germany, Great Britain, Sweden and the United States; the British members are Messrs W. Sclater and H. F Witherby Communications for the Congress should reach the honorary secretary, Mr. P. Bovien, c/o Mr E Lehn Schioler, Uraniavej, 14-16, Copenhagen, Denmark, not later than May 16

ACCORDING to the Rome correspondent of the *Times*, the Italian cabinet has approved a bill creating an Italian Academy, the objects of which will be the "co-ordination and direction of Italian intellectual movements in the field of science, letters, and arts, the preservation in these activities of the national character according to the traditions of the race, and the encouragement of its expansion and influence abroad" The Academy will receive an annual subsidy from the State, and grants and pensions will be assigned to authors, artists, and scientific workers, inventions examined and schemes for intellectual advance instituted Membership will be limited to sixty, the first thirty being nominated by Royal decree, on the advice of the President of the Council, and the remainder during the next ten years from a list of names preferred by the existing Academicians Academicians will have the privileges of high State officials and will wear a special uniform

WE learn that the beam stations for short wave radio communication which Marconi's Wireless Telegraphy Co, Ltd, is erecting for the British Government and for the Governments of the Dominions and India, are making satisfactory progress It had been hoped that the Canadian and South African stations would be ready for working by the end of 1925, but their completion has been delayed by the illness of Senatore Marconi and Mr Franklin It is expected, however, that the beam services between Great Britain and Canada and South Africa will be ready for working in April next, and that the services with India and Australia will be in operation about the middle of August A beam station is being erected at Dorchester for communication with the United States and with South America. A corresponding station is being built in Brazil for the account of the consortium of the four wireless companies operating in South America The Company is also constructing stations connecting Portugal and her Colonies and linking up Portugal with the rest of the world. This programme of construction involves the expenditure of approximately 1,000,000*l.* sterling

IN referring to the report of the British Photographic Research Association (December 26, 1925, p 944), we perhaps did not make it sufficiently clear that while the members of the staff of the Association took a very active part in the matter of the standardisation of plate-testing methods, the proposals that were placed before the sixth International Congress of Photography were drawn up by a committee appointed by the Scientific and Technical Group of the Royal Photographic Society.

WE have received the annual report and statement of accounts of Livingstone College for 1924-25 The College does a valuable work in imparting to those entering the mission field the elements of a medical training. Owing to a decrease in fees and extraordinary expenditure on making up roads adjoining the College there is a deficit on the year's working of 1340*l.* Subscriptions are appealed for, either for general purposes or to provide a memorial to the late Dr. Harford, the founder and first principal.

IN the notice of the Ray Society volume, "The British Hydracarina," by C. D. Soar and W. Williamson, in NATURE of December 26, 1925, p. 932, the bibliographic details might be taken to imply that this book was published by the British Museum (Natural History). We are asked to point out that this is not the case, and that the Ray Society has no official connexion with the British Museum apart from the fact that permission has been given for the Museum to be used as the official address of the Secretary of the Society Messrs Dulau and Co, Ltd, 34-36 Margaret Street, London, W 1, are the agents for the sale of the Society's publications to non-members and to the trade

APPLICATIONS are invited for the following appointments, on or before the dates mentioned · A professor of mycology at the Imperial College of Tropical Agriculture, Trinidad—A Aspinall, Imperial College of Tropical Agriculture, 14 Trinity Square, E C 3 (before end of January). A head of the Electrical Engineering department (*not engineering* as advertised in NATURE of January 2) of the L C C Hackney Institute—Education Officer (T. (1) (a)), County Hall, Westminster Bridge, S E.1 (January 18). A borough analyst and Corporation chemist for the County Borough of Salford—Medical Officer of Health, 143 Regent Road, Salford (January 20) A demonstrator in inorganic and physical chemistry at King's College, London—The Secretary (January 20) A Secretary to the Queen's University, Belfast—The Vice-Chancellor (January 30) A senior lecturer (male) in zoology in the University of the Witwatersrand, Johannesburg—The Secretary, Office of the High Commissioner for the

Union of South Africa, Trafalgar Square, W.C.2 (February 15). A dairy bacteriologist at the Harper Adams Agricultural College, Newport, Salop—The Principal. A junior professional assistant in the Meteorological Office—The Secretary. (S.2), Air Ministry, Adastral House, W.C.2. A research assistant in the physiology department of the Middlesex Hospital Medical School—The School Secretary, Middlesex Hospital Medical School, London, W.1. A temporary lecturer in mathematics at the University College of Swansea—The Registrar, University College of Swansea, Singleton Park, Swansea.

Our Astronomical Column.

COMET ENSOR.—A little more information has come to hand about this comet, which raises hopes that it may be an object of considerable interest next February and March. A telegram from the Cape Observatory was circulated by the I.A.U. Bureau on Dec. 18; it gave the position on Dec. 14 at $18^h\ 30^m$ U.T. as R.A. $3^h\ 38^m$, S. Decl. 61° 12′; daily motion minus 12 minutes of time, south 24′. A further telegram from S. Africa appeared in the *Times* of Dec. 19, stating that an orbit had been deduced which indicated Feb 12 as the date of perihelion, and some thirty million miles as the perihelion distance. These facts, with the above position and motion, have enabled Dr. A. C. D. Crommelin to deduce the following rough orbit:

$$T = 1926,\ \text{Feb. } 12{\cdot}5\ \text{(assumed).}$$
$$\omega = 5^\circ\ 16'$$
$$\Omega = 284\ \ 17$$
$$i = 123\ \ 13$$
$$\log q = 9{\cdot}4072$$

An ephemeris from this orbit shows that the comet may be expected to be visible in England about Feb 16, when it will be a morning star 1° east of the sun, and 4° north of it; it may then be visible in the twilight and have a considerable tail (it had one 15′ long at discovery). It continues its northward course, and by March 4 will be 35° north of the sun; it will rise 4½ hours before sunrise, and will thus be visible on a dark sky; it will afterwards become circumpolar, but will fade rapidly. This forecast should only be taken as giving a general idea of the course of the comet, the data being rough. But it may be expected to be the brightest comet since Mellish's of 1917.

The following elements have been telegraphed to the I.A.U. Bureau, Copenhagen; they were computed by Mr. H. E. Wood, of the Union Observatory, Johannesburg, from observations made there on Dec. 14 to 16 (about):

$$T = 1926,\ \text{Feb. } 12{\cdot}41\ \text{U.T.}$$
$$\omega = 353^\circ\ 44'$$
$$\Omega = 282\ \ 17$$
$$i = 122\ \ 52$$
$$\log q = 9{\cdot}5250$$

EPHEMERIS FOR 0^h

	R.A.	Decl.	log *r*.	log Δ.
Jan. 31	$21^h\ 31^m\ 39^s$	30° 40′ S.	9·6476	0·1139
Feb. 16	21 2 8	13 31 S.	9·5384	0·0892
Mar 4	20 59 24	18 16 N.	9·8028	9·9777
,, 20	21 58 56	55 4 N	9·9846	9·9620
Apr. 5	1 58 43	76 19 N.	0·1049	0·0696

NAKED-EYE SUNSPOTS.—On the few days during the past three weeks when observations of the sun were possible, a number of sunspots were visible. Two of these were so large that they were obvious naked-eye objects. The first of the two groups, consisting of a pair of large spots, was south of the sun's equator, and crossed the central meridian on Christmas day. The other group, made up largely of one great spot, was in north latitude 23° and was on the meridian three days later. It is the largest group of spots seen as yet this cycle, and is comparable with the largest groups of the preceding cycle, such as the great spot of August 1917 or the long stream of March 1920.

Of the three large spots noted in these columns in the issue of December 9, the third group (Nov. 18-30, latitude 17° N.) lasted long enough to cross the disc again. The leader spot of the stream was alone represented, however, but though the train had died out, its position was marked by an extensive region of bright faculæ clearly seen near the east and west limbs of the sun.

The following table continues the information of naked-eye sunspots given in two previous numbers:

Date on Disc (1925–26).	Central Meridian Passage.	Latitude.	Maximum Area.
Dec. 19–31	Dec 25·4	20° S.	1/550
Dec. 22–Jan. 3	Dec 28·3	23° N.	1/400

(Areas express the proportion covered of the sun's hemisphere.)

On December 27 and 28, two moderate magnetic disturbances were registered at Greenwich, the time corresponding roughly to that of the transit of the large northern spot. The movements shown by the magnets were, however, much inferior to those of a "magnetic storm." There have been no other recent magnetic disturbances of any consequence.

The year 1925 has shown a pronounced increase in the number and size of sunspots, especially during the latter half of the year; but the average latitude (about 20°) in which the spots have appeared indicates, from their corresponding latitude and frequency in previous cycles, that their maximum occurrence will be nearly two years hence.

THE DECEMBER METEORS.—Mr. W. F. Denning writes: "This shower was unusually strong this year on several nights, especially on December 12 and 13, and the time of greatest abundance appears to have been observed on December 12 at about 20^h new G.M.T. Mr R. M. Dole of Lansing, Michigan (Lat. 43½° N., Long. 85° W.), says: 'The Geminids were magnificent this year. The rate on December 10 was 30-40 per hour from a point about 2° W. of Castor. On December 12 the radiant was between α and β Geminorum 1/5 the distance from α to β.' He watched the shower between $7^h\ 45^m$ P.M. on the latter night and $2^h\ 3^m$ A.M. (local time) December 13. The horary rate at about 10 P.M. was 60, and this went on increasing so that at 2 A.M. the rate was more than 240 per hour. They were short, swift, red, very few left trails. A great number were about 6-7 magnitude. At about 1 50 A.M. several bright ones were seen, mostly dark red. It is possible that the maximum may have been after 2 A.M. The display seems to have been nearly equal to that witnessed on December 13, 1920, in the early morning, by two ladies at Bournemouth, when at the lowest estimate 5 per minute were counted, or 150 in half an hour's record, though the sky was partially cloudy.

"The meteors were also seen at their recent return by Mr. A. King, in Lincolnshire, who obtained a very successful series of observations on the nights December 10-14. He did not witness the same abundance as that reported from the United States, but conditions were not so favourable. On the early evening of December 13, meteors were casually observed to be surprisingly numerous by Mr J. Johnson and some friends from the Devonshire moors.

"The writer pointed out the probability of a rich return of these meteors on December 12, 20^h (new G.M.T.), in *Monthly Notices, Roy. Ast. Soc.*, vol. 84, p. 178. Mr. Dole's observation has proved that it occurred at the time and in the strength expected."

Research Items.

A PORTRAIT-STATUE FROM THE CONGO.—In *Man* for December, Mr. T. A. Joyce figures and describes an example of the royal portrait-statues of the Bushongo. Four of these statues were brought back from the Congo by Mr. Torday in 1909, of which three are now in the British Museum and one in the Musée du Congo Belge, Tervueren. This present example, the fifth known, which has recently been acquired by the Musée du Congo Belge, represents Mikope Mbula, 110th paramount chief of the Bushongo. Native report states that these statues of chiefs were carved only when an artist of sufficient calibre was discovered. The statue of Mikope Mbula conforms to the traditional pattern. It is of hard reddish wood and is some 62·8 cm. in height. The chief sits in the conventional cross-legged pose, his left hand holding a knife, his right on his knee. His ornaments and dress—a belt ornamented with cowries and a belt supporting a sitting cloth and armlets—are indicated by carving. An engraved brass ring is around his neck. The five statues are evidently the work of three different artists, of whom the sculptor of the present figure is inferior in expression of character, although in two points at least he is more correct—the proportion of the lower limbs and the details of the hands. The distinguishing emblem of this chief is a human figure sculptured on the plinth in front of him which may represent his slave-wife and refer to the fact that in his reign, marriage with a slave—previously forbidden—became a legalised practice.

SUMERIA AND INDIA.—In the October issue of the *Journal of the Royal Asiatic Society*, Mr. Mackay returns to the question of early relations between Mesopotamia and India which was raised by Sir John Marshall's description and illustrations of seals and other objects from the Indus Valley in the *London Illustrated News* of September 27, 1924. The seal, showing a figure of a bull standing over a heap of grain and three signs, one of them a fish, was found in 1923, in a chamber nearly two metres below the surface on the north-east side of the ziggurat of the Temple of Ilbaba at Kish, but is undoubtedly of earlier (Sumerian) date. Its resemblance to the seal found at Harappa is unquestionable. Further evidence of contact is seen in a number of beads, necklaces of carnelian and lapis lazuli, found in the last two seasons in graves at Kish, which are provisionally dated at 3000 B.C. The lapis lazuli might have come from Persia, but in view of the fact that India from time immemorial has been the home of carnelian working, the beads were submitted to Sir John Marshall, and pronounced by him to be similar to beads found in great quantities in India, dating from early to recent times. The technique of the Kish beads seems to be identical with that of the Indian beads. Every consideration points to India having been their place of origin or else a country with trade relations with both India and Mesopotamia. The lapis lazuli beads do not show the same finish in workmanship, and were therefore probably made by a different people.

SEA TROUT.—An addition to the steadily accumulated mass of valuable data, due to the work of the scientific staff of the Fishery Board for Scotland, with regard to the salmon and sea trout is given us by Mr. G. H. Nall in a "Report on a Collection of Sea Trout Scales from the River Hope and Loch Hope in Sutherland" (Fishery Board for Scotland, Salmon Fish., 1925, No. 1, Edinburgh and London, H.M.S.O., 3s. net). The material examined was collected during January and March, and July and August. Whilst the bulk of the scales were of normal type, there were some on which a period of rapid growth in winter was followed by a winter zone and a weak summer growth in the following year; on others there was little differentiation between river and sea life. Erosion was well marked in autumn and winter on the scales of maturing fish and kelts, but, in some cases, the erosion which was slight and regular round the periphery of the scales suggests the possibility of spawning marks being undetected occasionally. The greatest number of smolts, 60 per cent., migrated to the sea after three years' river life, 10 per cent. after two years, 26 per cent. after four years, and 4 per cent. after five years. For the Forth, Menzies found 68 per cent. migrating after two years, 31 per cent. after three years, and an odd fish going down after four years. As is pointed out by Mr. Nall, this illustrates the rule that the farther north a district lies the longer is the parr life. The data show a tendency for the younger smolts to mature later than do the older smolts. The period between the smolt migration and the first spawning varies from one to four years; the greatest numbers spawn in the second winter after migration as smolts, and those which do not spawn until the third winter are more numerous than those which spawn as finnock; after first maturity, the majority of the fish become annual spawners. Information respecting three out of seven recaptured marked trout was sent without an accompanying sample of scales. This is unfortunate and suggests the desirability of giving more publicity to the experiments. It is also desirable that some records of temperature be made during winter feeding to check the statement that abundance of food, not high temperature, is the dominant factor in producing wide rings on the scales of the Salmonidæ.

ENZYME IN PLANT GUMS.—Oxidase and diastase activity have been found in plant gums by Gilbert J. Fowler and M. A. Malankdar (*Journal of the Imperial Institute of Science*, Bangalore, Vol. 8 A, Part 12), these enzyme activities being much more marked in two gum-oleo-resins, myrrh gum and the gum of *Boswellia serrata*, than in gum-arabic. In the case of the Boswellia and myrrh gums, there is evidence that the oxidase may consist of the usual peroxidase-oxygenase system, and an alcohol soluble catechol compound may form part of this system. Analyses for manganese do not suggest that the traces of this element present can be correlated with the oxidase activity. The diastatic enzymes saccharify starch solutions, but are without action on unchanged starch or gum and have no dissolving action on hemi-celluloses. There is a note of some interesting experiments suggesting enzymic conversion of tannins into non-tannins by extracts of these gums.

THE ANDAMAN SEA BASIN.—Major R. B. Seymour Sewell has commenced a systematic study of the Indian Seas, and in a first paper (*Mem. Asiatic Soc. Bengal*, vol. 9, No. 1, 1925) he deals with the geotectonics of the Andaman Sea. The Andaman-Nicobar ridge connects the Arakan Yoma with the main ranges of Sumatra. It probably began to rise from the sea-floor in early Tertiary times as part of the outer arc of the great Alpine-Himalayan system. Simultaneously a shallow-water basin formed on the east, into which poured the great alluvium-charged rivers of Burma, and from which the waters escaped into the Bay of Bengal through channels between the Islands. At a much later date the Straits of Malacca were formed and permitted the entry of the Pacific shallow-water fauna into the Andaman Sea, where already an Indian Ocean fauna was flourishing. The same sequence of structural elements—upfolds, depressions and volcanic belt—can be traced across Burma, from the Bay of Bengal to the Mergui Archipelago, and from the Indian Ocean across Sumatra to the Malayan ridge. The greater part of the Andaman Sea is a large basin, but on the west it is complicated by the volcanic belt of Barran Island and Narkondam. Farther south, olivine-basalt has been dredged from a depth of 1240 fathoms, 35 miles east of the Central Nicobars. The distribution of coral-rock throws new light on the recent development of the Andaman anticline. Raised coral-beaches along the eastern coasts of the Islands indicate uplift, while a barrier reef, much interrupted, occurs on the west and points to subsidence on that side. Many other topics of geological and oceanographic interest are discussed; and all the available data of a fascinating and little known region are brought to bear on the problem of its origin and evolution.

CRETACEOUS GASTROPODA FROM PORTUGUESE EAST AFRICA.—Mr. L. R Cox has described a series of Gastropoda from Catuane and Incomanini in Portuguese East Africa (*Ann. Transvaal Mus*, 11, Pt 3) The deposits at the former locality are considered to be Upper Albian, while those of the latter probably belong to the Upper Mæstrichtian. The Catuane fauna is represented by nine species, three being described as new, while in point of numbers an indeterminate Chenopus is the most abundant form present. Of the sixteen species in the Incomanini fauna, not one has been identified with any previously known form, but they appear to indicate shallow-water and possibly estuarine conditions at the time of the deposition of the beds The two plates on which these fossils are represented are very unsatisfactory.

NEW MAGNETIC ALLOYS.—In the September issue of the *Journal de Physique*, M. H. Tscherning gives the results of his comparison of the magnetic properties of the new alloys "permax," manufactured by the Imphy Steel Works, and "permalloy," manufactured by the Western Electric Co. Both specimens were in strip form and were coiled spirally to make rings on which were wound the magnetising and induction coils. The induction coils were connected to a Grassot fluxmeter, the readings of which were taken for each change of current in the magnetising circuit. For a maximum field of 1 gauss, permax has an induction of 3350 gauss, a residual of 2760 gauss, and a coercive force of 0·45 gauss. Under the same conditions, for permalloy the figures are 7500, 4900, and 0·075 respectively. With the maximum field raised to 200 gauss, permax has an induction of 10,800 gauss, residual about 5000 gauss, and a coercive force only 0·48 gauss, while for permalloy and for electrolytic iron the figures are of the order of 19,000, 10,000, and 1 respectively. Permax is therefore inferior to permalloy in permeability but has a smaller hysteresis loss in strong fields and seems less liable to change its magnetic properties under rough treatment.

THE NUCLEUS OF RADIOACTIVE ATOMS—In a paper in the *Comptes rendus Acad. Sci*, Paris, of November 20, M. J. Thibaud assumes that a radioactive nucleus consists of a very dense central portion with a total positive charge Ne, that the force around it is central and given by the formula

$$F = Ne^2(1 - b^{a-2}/r^{a-2})/r^2,$$

and that certain positive elements of the nucleus move as satellites round this central portion in the narrow region where the force upon them is attractive. It can be shown that the only periodic orbits possible are circles and that the motions in them are unstable, which would account for the disintegration of these atoms. It is assumed that these orbits are quantised, like Bohr's electron orbits in the external portion of the atom. The γ-rays emitted by these elements apparently obey quantum laws, and the author finds in the case of mesothorium 2, by assuming $a = 3$, $N = 100$, $b = 3{\cdot}29 \times 10^{-12}$ cm. and that the emitting particle is a proton, that the energy differences $W_n - W_1$ as observed and as calculated are almost identical, n the quantum number having the different values 2, 3, 4 . . . 8 N and b agree with values obtained for the charge and diameter of a heavy nucleus by studying the deviations of colliding α-particles. The agreement is not so good when a is assumed to be 4 with a revolving α-particle.

THE AMMONIUM RADICAL.—Direct experimental evidence for the tetrahedral distribution of the hydrogen atoms of the ammonium radical about the nitrogen atom in simple ammonium compounds is given by W. H. Mills and E. H. Warren in the *Journal of the Chemical Society* for November. Spiroammonium salts were investigated and, by a simple diagram, it is shown that resolution is possible if the ion has the tetrahedral configuration Fractional crystallisation of the bromocamphorsulphonates yielded *d*-spiroammonium bromide, molecular rotation $[M]_{5461}$ of $+50{\cdot}5°$ and the corresponding *l*-salt $[M]_{5461}$ of $-50{\cdot}8°$.

PHOTOCHEMICAL DECOMPOSITION OF SILVER CHLORIDE.—The microbalance has been employed by E J. Hartung to investigate the photochemical decomposition of silver chloride. The work is described in the *Journal of the Chemical Society* of November; thin films of chloride on silica sheets were sealed in tubes with different chlorine absorbents. After insolation for definite periods, the tubes were opened, air, nitrogen, or hydrogen admitted, and the films weighed The decomposition into silver and chlorine has a maximum value of 91·1 per cent, 89·8 per cent., and 94·8 per cent, in air, nitrogen and hydrogen respectively. In addition, experiments on the rate of chlorination of silver and previously insolated silver chloride are described, and these show that a maximum rate exists for certain concentrations of chlorine in air. No evidence of the existence of a subchloride was obtained.

ORIENTATION OF CRYSTALS IN METALS.—Two papers in the *Memoirs of the College of Science of the Kyoto Imperial University*, Ser. A, Vol. 8, No. 5, Aug. 1925, deal with the orientation of the crystals in cold-worked metals of the face-centred cubic type The X-ray patterns obtained from platinum plates which have been cold-rolled from a thickness of 0·5 mm. to 0 03 mm. suggest that the majority of the crystals are so arranged that a dodecahedral face lies parallel to the rolled surface, the direction of rolling being perpendicular to a trigonal axis lying in this face. This ideal arrangement does not exactly hold for all the crystals, the dodecahedral planes of some being rotated slightly around the direction of rolling. In the case of gold leaf, the surface of the leaf is a cube face. A second investigation of the orientation of the crystals in cold-drawn aluminium wire suggests that a trigonal axis lies nearly parallel to the axis of the wire, the orientation being otherwise somewhat at random. The deviation of the trigonal axis from that of the wire is most generally about 7°. The exact amount of reduction in drawing is not given. An examination of a cold-drawn copper wire shows that the orientation of the crystals is identical with that in aluminium.

Some Diseases of Cotton as seen in the Plantations.[1]

IN order to facilitate research work being carried out in the University of Manchester, for the Empire Cotton Growing Corporation, a visit was paid to some of the cotton states of America in the summer of 1924. The diseases of cotton described were observed in the plantations of North and South Carolina. In that season, according to recently published estimates by the U.S. Department of Agriculture, fungal and bacterial diseases of cotton reduced the crop in the U.S.A. by 1,900,000 bales. The extent of these losses in what was a relatively favourable season for cotton-growing indicates the importance of these diseases.

In the United States some diseases are more important than others, but, at the present time, all of them may be important to Great Britain in view of the considerable extension of cotton-growing in progress in various parts of the British Empire. In some of these countries a new crop plant is being introduced; we have little knowledge how it will react to its new environment and we do not know what diseases will appear. It is certain, however, that some diseases will occur, and it is well known that a disease which is relatively harmless in one country may become destructive in another. This may be illustrated by some of the diseases seen in the United States. *Bacterium malvacearum* causes the angular leaf spot and a boll disease on Upland varieties of cotton (*Gossypium hirsutum*), the leaves and bolls usually being the only parts of the plant affected. The Sea Island and Egyptian varieties of cotton (*G. barbadense* and *G. peruvianum*) are much more susceptible to the attacks of the organism, which also affects the leaf-stalks and branches, causing the "black arm" form of the disease. This "black arm" disease is already causing serious concern in the Sudan on Egyptian cotton, although in Egypt, presumably on account of the different climatic conditions, it is not troublesome. It is now known that infection may be carried on the seed, and seed-disinfection has proved successful in preventing the disease in the United States.

Again, in the U.S.A. several root-diseases of cotton occur. Of these the Texas root-rot (Ozonium) and the wilt disease caused by *Fusarium vasinfectum* are of most importance. In the latter case the disease was studied in South Carolina on badly infected soils. The fungus present in the soil passes into the conducting tissues of the plant and, excreting poisonous substances, leads to dwarfing, wilting and killing of the whole plant. In the Sudan a root-disease (the Tokar root-rot), undoubtedly different from the Fusarium wilts or Texas root-rot, but capable of stunting and killing the plant by progressive infection, is also causing trouble. Work at present in progress on this disease should ultimately determine its cause and probably provide for its control.

Diseases of the immature or opened bolls are commonly caused in the U.S.A. by *Glomerella gossypii* (anthracnose disease), Fusarium, Diplodia, and by *Bacterium malvacearum*. The cotton lint is destroyed, weakened or discoloured by such organisms. Similar boll diseases occur wherever cotton is grown, and recent studies by Mr. R. W. Marsh on discoloured cotton from Nyasaland have shown that the yellow discoloration is due to a species of Nematospora, a fungus. In the West Indies this fungus has been shown by Nowell to be inoculated into the bolls by cotton stainer bugs, which puncture the bolls as they feed. Stainer bugs were observed feeding on cotton bolls in South Carolina, but up to the present the Nematospora fungus is not known to cause disease of cotton in the U.S.A.

Other diseases of cotton studied were those caused by species of Alternaria and *Ascochyta gossypii*. These have not hitherto been of serious consequence in the United States, but the latter is now spreading and both diseases may prove much more harmful in other countries.

Of the diseases to which reference has been made, several have as yet been imperfectly studied, and only by extended work on such diseases and on the organisms responsible for them will it be possible for the growers and plant pathologists in cotton countries to guard against outbreaks of disease and to devise satisfactory means of control when such outbreaks occur.

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[1] Substance of paper read before the Manchester Literary and Philosophical Society by Dr. Wilfrid Robinson on December 8.

Causes of Volcanic Activity.

ON the occasion of the centenary of the Franklin Institute in 1924, Dr. A. L. Day delivered an address on volcanic activity, which appears in the journal of the Institute for August 1925. It is well known that the crater of Mauna Loa is 10,000 feet higher than the lava lake of Kilauea. Since more lava emerges from the higher vent than the lower, and eruptions rarely occur simultaneously, it is clear that the two vents cannot be connected with a continuous liquid interior. The changes of level of the lava of Kilauea would show periodic tidal effects if there were a molten cauldron underneath, but they fail to do so. Moreover, the lava lake was recently drained to a depth of 1500 feet, and a solid relatively cold bottom was exposed. A number of channels leading in from below were detected on the side walls.

Another firmly established conclusion is that the varying temperatures and fluidity of the lava are due to irregular uprisings of gases. These have evidently come from isolated chambers in which crystallisation is approaching completion, but at different stages from place to place. The gases pass up through various channels into the central basin, where they meet and react, and so produce the heat necessary to maintain the superficial vulcanism. The gases actually collected from the lava include hydrogen, chlorine, and sulphur, which, in association with others, make an unstable mixture that could not have come from any single source, since it is in a state of active exothermic reaction.

Modern volcanoes thus appear to be controlled by the liberation of gases from a crystallising mass below, and are very different phenomena from the fissure eruptions that gave rise to the great basalt plateaux of the Deccan and the Brito-Arctic region. The conclusion is amply confirmed by the study of the recent explosions of Lassen Peak, which were essentially due to the release of steam from a closed chamber of crystallising magma beneath the crater. Practically no chemically active gases were discharged, and consequently the temperature remained much lower than at Kilauea, and no lava was emitted.

No other North American volcano, and few in the whole world, have been investigated so thoroughly as Lassen Peak, and the magnificent memoir by Dr. A. L. Day and Dr. E. T. Allen (Carnegie Inst. of Washington, Pub. No. 360, 1925) dealing exhaustively with its activity in 1914–17 will take a high place in the literature of vulcanism. Lassen Peak began its life as a volcanic centre in early Neocene times, and has continued with diminishing violence down to the present day. It is now an old and dying volcano, for the explosive eruptions which began in 1914 followed a period of apparent extinction which had lasted at least two centuries. Only once during its four years of activity were red-hot ejecta witnessed, and it seems to be completely established that high temperatures, such as are attained at Kilauea or Vesuvius, played no part in the eruptions. The first explosions broke through the snow-filled crater basin, and open cracks developed, down which the melted snow disappeared. A year later a lid or plug of dacitic andesite was forced up the vent to the level of the old crater-rim, and just failed to rise sufficiently to expose the underlying volcanic hearth. A plane of weakness was formed, however, on the north-east side of the cone, and through this two devastating horizontal blasts forced a passage. The adjacent valleys were stripped of all vegetation for four miles, but no fires were started save momentarily where a few dead leaves were ignited. Trees were merely scorched. Solid ejectamenta embedded themselves in the snow without melting any appreciable quantity. The great floods that followed a day or two later were most probably caused by the condensation of superheated steam from the volcanic cloud.

The outburst seems to have been assisted by an earthquake that weakened the structure of the volcano, and also by the flowing of water from melted snow down the first-formed cracks. But though this water must have participated in the tremendous steam-explosions that followed, it can scarcely have been an essential contributory cause, for the violence of the eruptions increased long after the snow had gone, and quantitatively it was inadequate to account for the enormous volumes of steam that escaped during the 300 or more explosions that afterwards occurred. Another source for the steam must therefore be postulated. The authors suggest that the gases responsible for the explosions were for the most part in solution in the crystallising magma beneath the crater, water being by far the most abundant ingredient of these volatile constituents.

It is now well known that a silicate magma can hold a considerable quantity of water in solution under appropriate conditions. G. W. Morey has pointed out (*Journ. Washington Acad. Sci.*, vol. 12, p. 219, 1922) that as crystallisation proceeds with falling temperature, the pressure of the volatile constituents increases at a rapid rate. This deduction from laboratory experience and thermodynamical reasoning goes far towards elucidating, not perhaps the entire problem of vulcanism as Dr. Day claims, but certainly most of the superficial phenomena of present-day volcanoes. The discharge of water during crystallisation must develop immense pressures when it takes place in a closed cauldron. The pressure may find relief in a single tremendous explosion, as in the case of Bandai San; or intermittently, as at Mt. Pelée or Lassen Peak, according to the rate of release of the water, and the roof conditions permitting or resisting its active escape. That the water-content of magmas before crystallisation is greater than that of crystallised rock is proved by the high percentage of water which is retained by obsidians and pitchstones.

The concluding sentences of Dr. Day's address summarise a long and consistently sustained argument: "Through all of these studies our conclusion seems to stand fast wherever it is applied, namely, that the outstanding factor in determining the character of modern vulcanism is the gas content of the crystallising magma. If this be mainly of steam released in a closed chamber, as at Lassen Peak, then only steam explosions are to be expected as the surface manifestation of the crystallisation of the magma below; if to the steam are added such chemically active gases as chlorine, sulphur, hydrogen and the hydrocarbons, then chemical reaction between these will be a sufficient cause of higher temperatures, and lava flows of the character well known at Vesuvius, Stromboli or Kilauea."

ARTHUR HOLMES.

Diseases of the Hop.

A NUMBER of interesting communications have recently appeared dealing with diseases of the hop. In particular a paper by E. S. Salmon and W. M. Ware (*Annals of Applied Biology*, 1925, 12, 121) discusses in detail a downy mildew which was first found in Europe in 1920 at the experimental hop gardens of Wye College. Since that year the intensity of the disease has been increasing rapidly, and it may become a serious factor in hop production in the future.

Previous to 1920 the disease was observed in Japan in 1905 (*Pseudoperonospora Humuli* (Miyabe and Takah.) Wils.) and in the United States in 1909, and there appears to be little doubt that the three diseases are identical. In 1923 the opinion was expressed that the fungus causing the disease had been imported into Great Britain from one of the countries mentioned, but subsequent work has led to the conclusion that it is indigenous. The downy mildew which is common to the nettle, *Peronospora Urticæ* (Lib.) de Bary, has been found to differ only as regards the size of the oospore from that occurring on the hop, and cross-inoculation experiments have led to the suggestion that the fungus may be transferred from one to the other. This is supported by the fact that infected nettles have often been found in close proximity to infected hops. Assuming then that the fungus from the nettle has found a new host, it would seem that the chance of infection becomes greater in a wet than in a dry season. This might account for the great increase in infection during the particularly wet season of 1924. On the other hand, a process of evolution may be taking place in which the hop is being infected by new forms of the downy mildew of the nettle, and in this case the prospect is rather more serious. Consequently the results of investigations during the 1925 season will be awaited with great interest.

It may also be mentioned that a similar disease has recently been noted for the first time in Germany, and as the nettle mildew is known to occur in the hop-growing districts of that country, some light may be shed on the problem from this quarter.

The disease is characterised by the appearance on the hop leaf of reddish-brown angular spots. Under the microscope these can be seen to consist of hair-like growths, which differ from ordinary hop mildew in that they are branched instead of unbranched. The branches bear conidia which drop off and spread the disease by germination in the presence of water. The hop cones may also be attacked, in which case the whole cone may turn brown and wither.

These symptoms must not be confused with those arising as a result of the "browning of cones" disease which in recent years has attacked hops on the Continent. This disease is also characterised by a shrunk epidermis which contains a reddish-brown substance, and has been ascribed by Wagner (*Tageszeit. Brau.*, 1924) to the exceptionally unfavourable weather conditions of 1924, rather than to a particular organism. P. Lindemanns (*Pet. Jour. du Brass.*, 1925, 33, 189) has stated that the disease was due to lack of nourishment of the cones. This was a result of the insufficient supply of sap, the transpiration being checked by the excessive humidity of the atmosphere. Thus, when the rows of hops had been planted in the direction of the prevailing winds, the disease was less marked than in the case of plants from damp and low-lying parts. J. G.

University and Educational Intelligence.

CAMBRIDGE.—Mr R. E. Priestley has been appointed Assistant Registrary with the duties of Secretary to the Boards of Examinations and Research Studies. Mr. Priestley was a member of two Antarctic Expeditions; he entered the University as a research student in geology in 1913; became a fellow of Clare College in 1923 and has been secretary to the Board of Research Studies for two years.

Two lists of successful candidates in the recent scholarship examinations have been published. An analysis of the awards of open scholarships and exhibitions shows that 35 are for natural science, 42 for mathematics and 113 for other subjects—classics, history, languages, etc. A further point of interest lies in the distribution of the successful candidates among the schools. It is often nowadays no easy matter to decide whether any place of secondary education is a "public school" in the generally accepted sense of the term. It is possible, however, to draw up an arbitrary list which will include those schools which the majority of educated people would call "public schools." The present writer has ventured to construct such a list, and has grouped the new scholars and exhibitioners according to it. The following figures have been obtained:

	Nat. Sci.	Math.	Other Subjects.
From Public Schools .	11	21	65
From other Secondary Schools . . .	24	21	48

Any deductions made from these figures are liable to severe criticism, but three hypotheses suggest themselves:

(1) The public schools divert the majority of their best scholars in directions other than scientific ones.

(2) The teaching of "other subjects" in the public schools is superior to instruction in them in the other schools.

(3) The teaching of science in other schools is generally superior to that in the public schools.

It is commonly believed in Cambridge that (3) is certainly partially correct in many cases. Perhaps it is time that the public schools gave the matter further thought.

ACCORDING to the report recently issued by the Secretary of the Rhodes Trust, the number of Rhodes Scholars in residence during the year 1924–1925 was 185, of which 96 were from the British Empire and 89 from the United States, 63 took up their scholarships for the first time. The present academic year started with 185 scholars in residence. From the table showing the distribution among subjects during the past year, it appears that 48 were taking natural science and medicine and 2 mathematics. Five Rhodes Scholars were awarded the degree of D.Phil., three of them being natural science students. Reference is also made to distinctions gained by former Rhodes Scholars, among whom are R. B. Brode, awarded a research fellowship by the National Research Council of America; H. W. Florey, appointed to a Rockefeller medical fellowship; and E. P. Hubble, who was awarded half the American Association for the Advancement of Science Prize for 1924 for his researches on nebulæ. Notice was received during the year of no less than 33 new books by Rhodes Scholars, of which only 4 have a bearing on science. The scholarships are to continue to be of the annual value of 400*l*. each. A site has been purchased at Oxford for the erection of a building to be known as "Rhodes House," which will be the residence of the Oxford secretary and will contain a library and a hall for the annual dinners of the Trust. Information as to the scholarships may be obtained from the offices of the Trust, Seymour House, Waterloo Place, London, S.W.1. In the United States application may be made to President Aydelotte, Swarthmore College, Swarthmore, Pennsylvania, in Canada to Mr. J. M. Macdonnell, National Trust Company, Limited, Montreal, P.Q., in Australia to Dr. J. C. Behan, Trinity College, Parkville, Victoria; in South Africa to Mr. P. T. Lewis, Court Chambers, Keerom Street, Cape Town.

APPRENTICES in H.M. Dockyards have to attend school for a certain number of hours each week, and any one who knows the Dockyard schools and the instructors in them is not surprised at the successes of the students, for no better scientific and technical education for youths is given anywhere in Great Britain. As, however, the apprentices are educated at the public expense with the view of their becoming shipwrights or fitters in the Dockyards, and as they have many decided advantages over students in technical schools outside, it seems scarcely just that they should be able to use these advantages to secure scholarships intended for science students generally. Judging from the list, just issued by the Board of Education, of successful candidates for Royal Scholarships and Free Studentships, and from the latest list of awards of Whitworth scholarships, there is little prospect of success for any candidate who has not been educated in a Dockyard school, particularly for scholarships in engineering subjects. Thus, there were seventy-one competitors for Group A (Engineering) for Royal Scholarships and Free Studentships in the 1925 examination, and each of the eleven successful candidates was a Dockyard apprentice. In the other groups—physics, chemistry, biology, and geology—all the successful candidates were from schools and colleges not in the Dockyards. Nearly all the Whitworth scholars in the last list were from the Dockyard schools, and so it has been for several years. This must be discouraging to teachers and students in other technical schools and colleges, and we suggest that the Board of Education might well give attention to the matter with the view of arriving at a more equitable adjustment of the awards. It was never intended that Royal and Whitworth Scholarships should be a special reserve for students in such institutions as H.M. Dockyards, where exceptional opportunities of preparing for them are enjoyed, both as regards the advantage of being given school time in working hours and as regards the practical and theoretical instruction afforded.

Contemporary Birthdays.

January 9, 1866. Prof Charles J Martin, C M G. F.R S

January 12, 1862. Prof. John G. Adami, C.B.E., F.R.S.

January 13, 1842. Sir Alfred F Yarrow, Bart, F.R.S.

January 13, 1843. Sir David Ferrier, F R S

January 13, 1858. Sir D. Orme Masson, K.B.E, F.R S

January 13, 1869. Sir Richard Paget, Bart.

Prof. J. G. ADAMI, Vice-Chancellor of the University of Liverpool, was born at Manchester Educated at Owens College in that city, he entered Christ's College, Cambridge, in 1880 In 1887 he became a demonstrator of pathology in the University, and afterwards John Lucas Walker student of pathology Prof. Adami was appointed Strathcona professor of pathology and bacteriology, McGill University, Montreal, in 1892, this post leading to important developments and highly appreciated issues of work whilst in Canada. President of the Canadian Association for the Prevention of Tuberculosis, 1909–12, he was president of the Association of American Physicians, 1911–12. Prof Adami has written much on the nature of inflammatory processes. A joint paper with the late Dr C S. Roy, "Contributions to the Physiology and Pathology of the Mammalian Heart," was published in the *Philosophical Transactions of the Royal Society.*

Sir ALFRED YARROW was born in London in 1842. Our cordial congratulations are offered on the occasion of his eighty-fourth birthday. He was educated at University College School, London. Beginning business as a shipbuilder and engineer at Poplar, he migrated to Clydeside in 1906, continuing, as the founder of the world-renowned firm which carries his name and flag, the building of merchant ships and supplying the multifarious requirements of British Navy craft. An early and generous benefactor to the National Physical Laboratory, the wider demands of science in general have found aid and maintenance through his munificence. So recently as 1923 Sir Alfred made a gift of 100,000*l*. to the Royal Society for administration as a research fund.

Sir DAVID FERRIER, emeritus professor of neuropathology, King's College, London, was born at Aberdeen in 1843, and thus has reached the ripe age of eighty-three years Graduating at Aberdeen in 1863, he studied as well at the Universities of Edinburgh and Heidelberg Sir David is specially identified with researches on the localisation of cerebral functions, begun fifty years or more ago. In presenting one of the Royal Society's Royal medals to him in 1890, the then president recorded that "we owe to Prof. Ferrier's experiments in monkeys, animals which he was the first to use for this purpose, the beginning and indeed the greater part of our knowledge of cerebral localisation in man. Broca located the centre for speech in the third left frontal convolution, but with this exception nothing was known of cerebral localisation in man until Ferrier commenced his experiments in 1873" By experiments upon monkeys Ferrier was able to map out the most important motor areas with great precision, and the results were eventually turned to practical account in cerebral surgery.

Early Science at Oxford.

January 11, 1683–4. A letter from Mr. Aston mentioned an Analysis of ye stone of ye bladder, given in to ye Royall Society, by Mr Lister, who affirms, that ye Lapidescent juices within ye body, are ye same with those which are without it; and that ye *Caput mortuum* of ye stone, will apply to a Magnet, like other pyrites.

The Minutes of what has passed in ye new Society of Dublin were read; They gave an account of severall discourses, of a differing nature, which have been read at their meetings; Wee shall in a little time, have copies of them. It was then ordered, that thankes should be return'd to ye gentlemen of that Society for ye favor of their correspondence, and that ye Minutes of this Society should constantly be sent them

An account was given of severall late distillations of brine, made by Dr. Plot and Mr Musgrave.

1686–7. Mr. Pit communicated an account of the peristaltic motion of the stomach, observed in a dog in July 1685 and also of lacteals arising from the stomach. He was desired to try if he could discover any lacteal veins in Birds.

January 12, 1685–6. Mr Flamsteed's Tide-Table for ye year 1686 was presented to ye Society, and Mr. LLoyd presented a Catalogue of ye Shells in ye Musæum Ashmoleanum.

Dr. Plot communicated a Table for ye keeping a Diary of Weather-journall by observing ye station of ye quicksilver in ye Baroscope, ye place of ye Spirits in ye Thermometer, the points and strength of the Wind; and ye state of ye Weather: together with an account of Weather-glasses exactly made and sold (as the table also is) by Mr. Jo: Warner, London.

January 13, 1684–5. Dr. Smith (in ye chair, in ye absence of ye President,) acquainted ye Society, that according to a MS. of Julius Africanus, belonging to Magdalen Colledge, (which MS. he thinks is about 200 years old,) ye citation of Vossius out of this Author, concerning ye making of Ignis Græcus, is exact.

A Cubicall measure, of a Quantity given, was proposed to be provided; Mr. Caswell, and Mr. Walker were desired to enquire, concerning ye making one, with it ye difference as to weight, between ye same measure of severall sorts of substances, as grains, earths &c of diverse kinds, may be examined, and ye quantity of water &c. exhaling from a given space, in a time given, may be found out; an account of which will make much toward ye clearing this quere, viz whether the water of ye Mediterranean is disposed of by way of vapor?

According to Mr. Charles Leigh, they have in the County of Lancashire an earth, never yet plowed in ye memory of man, in which (about 2 yards under ye surface) he has found severall grains of corn, not in ye least rotted; he has seen trees in it perfectly sound, it will preserve any kind of flesh; and (he thinks) it may make compleat Mummies.

He says, they have a Tobacco-pipe clay, which will dissolve in water, and take out any spot: that they have a fish, which (he thinks) is the sepia, for if they offer to catch it, it will immediately make ye water look as black as ink. Another fish in that Countrey, has a prickle on its back; with which, if the seamen are at any time prickt, ye part will certainly gangrene; this prickle, he says, is hollow, and is inserted into a little bladder, out of which ye poyson proceeds, after ye same manner as in Vipers

Mr Welsteed communicated an account of making turpentine, tar, rosin, and pitch near Marseilles, by Mr. Tho Bent M A. lately of Lincoln College.

Societies and Academies.

LONDON.

Geological Society, December 16.—W. D. **Lang** and L. F **Spath**: The black marl of Black Ven and Stonebarrow, in the Lias of the Dorset coast Pt. I. (W D. L.) The Black Marl Series of the Geological Survey includes Oppel's zones of *obtusus*, *oxynotum*, and *raricostatus*. The lowest part of the series—the Shales-with-Beef, has already been described in detail At least twelve horizons can be recognised in the Black Marl above the Shales-with-Beef; as well as two non-sequences. Pt. II (L. F S) New species of ammonites from the Black Marl are described Notes are also added by Dr. A. E Trueman on the Echioceratid ammonites; by Mr. L. R Cox on the lamellibranchs; and by Miss H. M. Muir-Wood on the brachiopods.

EDINBURGH.

Royal Society, December 21.—Sir J J **Thomson**: The intermittence of electric force. It is supposed that when a body is under the action of such a force, the increments it receives are each finite in amount and separated by finite intervals of time, the average interval of time being called the time interval of the electric field. For events which last over a large number of time intervals the results are the same as those given by the Classical Theory of continuous force, but for events which can happen in the very short time comparable with the time interval of field an entirely different treatment is required The path of an electron in an electric field would, on this view not be a curve of continuous curvature, but an irregular polygon with a very large number of sides. The intermittence of electric force would lead to some spontaneous dissociation of systems consisting of electrons and positively charged particles, and to the production of Rontgen rays when electrons passed near atoms, but these rays would be very soft unless the electrons moved so quickly that the time they were in the neighbourhood of the atom was comparable with the time interval of the electric field in the atom Since the time interval gets longer as the strength of the electric field diminishes, periodic electric waves cannot spread out indefinitely into space, for as they travel outwards the intensity of the electric field diminishes and ultimately gets so weak that its time constant is long compared with the period of the waves, the waves will be reflected back at this stage and thus the energy will be confined to a limited volume, and the shorter the period of the waves the smaller will be this volume This shows that the energy of light must travel in bundles which do not spread out as they travel through space The conception simplifies the dual theory of light recently brought forward by the author, as it ensures that the energy of the electrical waves in the unit of light should be constant as well as the energy of the quantum.—A R **Forsyth**: A chapter in the calculus of variations: maxima and minima for weak variations of integrals involving ordinary derivatives of the second order The paper constructs the tests for the possession of a maximum or a minimum, by integrals that involve first and second derivatives of an unknown quantity. The curve, representing the relation between the dependent variable and the independent variable, is subjected to completely arbitrary variations throughout its length, these being small in magnitude as regards position, direction, and curvature The tests are sufficient, as well as necessary, for the small variations specified.—A C **Aitken**: On the theory of graduation. A paper dealing with Prof E T. Whittaker's theory of the graduation of data A new method of solution is proposed which is better adapted for computation and also brings out a comparison with other extant methods of graduation.—C E **Weatherburn**: On triple systems of surfaces and non-orthogonal curvilinear co-ordinates.

SHEFFIELD

Society of Glass Technology, December 16.—W E. S **Turner**: The composition of glass suitable for use with automatic machines A survey was made of the whole field of glass compositions which have been used, particularly for glass bottles, from the time of the Roman glass makers down to the present day. The introduction of the automatic machine has much limited the range of compositions available For example, in using a number of types of machines the percentage of lime in the glass cannot be raised safely above 10 per cent., whereas in some of the glass used on the continent and worked by hand 20 per cent sometimes occurs The factors which decide the limits of composition are the size of the article, whether colourless or coloured; the method by which the machine is to be charged, that is to say, whether by suction or by gob feeding; and finally by the type of machine itself. Scientifically, the factors of importance are the viscosity of the glass, the rate at which the viscosity changes with temperature, the heat conductivity and heat radiation.—Violet **Dimbleby** and W E. S. **Turner**. The relationship between the durability and the chemical composition of glass Tests were made of glasses of similar type in which soda was replaced successively by lime, magnesia, alumina, titania, zirconia, barium oxide and boric oxide. In all, 70 to 80 individual glasses were prepared, and the action of the four reagents, namely, boiling water, hydrochloric acid, sodium carbonate and caustic soda solution, were tested.

CAPE TOWN.

Royal Society of South Africa, October 21.—P. R. v.d. R **Copeman**: Note on the decrease in acidity during the ripening of grapes. The most important changes occur in the sugar and acid content of the juice. The acidity, as determined by titration, decreases during ripening, and when the logarithm of the acidity is plotted against the time, a straight line is obtained. The concentration of acid varies with the time, and the rate of decrease is proportional to the existing concentration. The acidity at any given time depends upon the variety of grape The rate of decrease of acidity is independent of the variety, but is dependent upon some seasonal variation The rate at which grapes ripen during any given season is independent of the variety At maturity the decrease in acidity becomes practically negligible.—Alexander **Brown**: An extension of Ceva's theorem to polygons of any number of sides For a polygon of $2m$ sides it gives $m-1$ relations, and for a polygon of $2m+1$ sides it gives m relations. Various special results already known can be derived as particular cases.—L. P. **Bosman**. The hydrolytic properties of certain amino-acids. Falk and Nielson state that the amino-acids glycine, alanine, leucine, aspartic and glutamic, bring about the hydrolyses of esters such as methyl acetate, ethyl butyrate, and olive oil. The actual hydrolyses cannot, however, be attributed to the fact that these acids contain the amino-group. The acidity of the medium seems to be the cause of the hydrolyses.—D. B. **Swart**: Note on the South African marine mussel, *Mytilus Meridionalis*, Krauss (1848). *M. Meridionalis* is established beyond all doubt as a distinct species.—H G **Fourcade**: (1) On instruments and methods for stereoscopic surveying (2) The optical transformation of projections and its application to mapping from air photographs. (3) On some conditions for the accurate vision of stereoscopic pictures

ROME

Royal Academy of the Lincei, November 1.—**G. Armellini**: An apparent oscillation of the solar diameter. Experiments carried out in the Royal Campidoglio Observatory. Measurements made in three Italian observatories in 1924 give, for the sun's diameter, values lower than those obtained in 1923. Support is thus furnished to Hilfiker's and Lane's hypothesis that the sun is a pulsating star.—**F. Zambonini** and **G. Carobbi**: Double sulphates of the rare earth and alkali metals (iii). Double sulphates of lanthanum and sodium. Investigation of the isotherm for 25° indicates the formation of the stable compound, $La_2(SO_4)_3$, Na_2SO_4, $2H_2O$.—**F. Zambonini** and **R G Levi**: Researches on the isomorphism of the molybdates of rare earth metals with those of calcium, strontium, barium, and lead. Röntgenographic analysis shows that the compounds $CaMoO_4$, $SrMoO_4$, $BaMoO_4$, and $PbMoO_4$ possess identical crystalline structures.—Mineo **Chini**: Plane lines, for which the length of the arc is given in polar coordinates, as a function of the anomaly of the extremity.—**G. C. Evans**: The simple potential, and Neumann's problem.—Mentore **Maggini**. The orbit of the binary system OΣ 535, deduced from interferometric measurements.—**V. Ronchi**. The ocular interferometer.—Rita **Brunetti**: The effect of chemical linking on the energy of intra-atomic levels.—**A. Pontremoli**: The orientation in a constant electric or magnetic field in the hypothesis of molecular anisotropy.—**L. Tieri**: Determination of Avogadro's constant by means of doubly refracting solutions of dialysed iron. Results are obtained which show that even liquids which under the ultramicroscope appear to contain in suspension granules of only one type, actually contain granules of different magnitudes. There results, therefore, increased condensation of the granules at the bottom of the liquid, and consequently, for the lower layers, greater double refraction than corresponds with Laplace's law.—Luigi **Rolla** and Giorgio **Piccardi**: Chemical statics of electronic phenomena.—Mario **Amadori**: Products of the condensation of glucose with *p*-phenetidine.—Michele **Giua**: Influence of substituents on the formation and stability of various cyclic compounds. In connexion with the nuclear tension of coumaranone and coumarandione compounds, the condensation of malonyl chloride with β-naphthol has been investigated.—Pietro **Saccardi**: The nature of melanogen. When injected into the animal organism, pyrrole does not pass unaltered into the urine, but is converted by oxidation in the organism into a melanogen which yields an azo-compound different from that furnished by pyrrole.—Tullio **Carpanese**: The epidote of Monte Rosso di Verra (Monte Rosa group). This mineral, of specific gravity 3·343, exhibits the crystallographic constants, $a:b:c=1{\cdot}5803:1:1{\cdot}8045$, $\beta=64^\circ\ 34{\cdot}5'$, and a composition in good agreement with the formula $HCa_2(Al, Fe)_3Si_3O_{13}$.—Cesare **Artom**: Obligatory correlations of true tetraploidism (giantism and cellular magnitude).—Gustavo **Brunelli** and Ettore **Remotti**: The physiologico-etiological significance of the secondary sexual characters in Gambusia.

SYDNEY.

Royal Society of New South Wales, November 4.—**J. C. Earl** and **V. M. Trikojus**: The constitution of australol. The identity of the solid phenol, australol, isolated from certain eucalyptus oils by the late Mr H. G Smith, with *p*-isopropyl phenol, has been established. For the purpose of comparison, *p*-isopropyl phenol was prepared synthetically by the following scheme of reactions: magnesium phenyl bromide + acetone ⟶ phenyl methyl carbinol ⟶ isopropenyl benzene ⟶ cumene ⟶ sodium cumene *p*-sulphonate ⟶ *p*-isopropyl phenol.—**A. R. Penfold**: The essential oils of *Melaleuca linariifolia* and *M. alternifolia*. Both these tall papery-bark tea trees follow the water-courses of the coast districts of N S Wales and southern Queensland, the former being abundant around Sydney, whilst the latter is plentiful at Copmanhurst on the Clarence River. Terpinenes, cymene, d-a-pinene, cineol, sesquiterpenes (cadinene), and terpinenol-4, with a little sesquiterpene alcohol, are the principal constituents of the essential oils.—**Leo A. Cotton**: Note on the earthquakes at Murrambateman during March and April 1924, and January to April 1925. Although the continent of Australia lies outside the two great earthquake belts of the world in which 95 per cent. of all recorded shocks occur, there are certain areas which are subject to occasional earthquakes. The Yass district is one which has from time to time been shaken, but there is no previous record of such a seismic spasm as that which affected this district during the months of March and April 1924. Altogether some nine or ten shocks were recorded in this interval. The first earthquake was the most pronounced, and the information secured from many residents in the district show that the isoseismals have a pronounced L-shaped distribution which is attributed to movement along two faults which act as partial boundaries of an unstable earth block. A recurrence of seismic activity in the district took place during the period January to April in the following year (1925). Five shocks were recorded in this interval.—**M B Welch**: The identification of the principal ironbarks and allied woods. Australia's most valuable hardwoods for heavy constructional work, railway sleepers, poles, etc., are the ironbarks. It is, however, very difficult to separate these woods from certain timbers known as grey gum, which are often substituted for the former. Certain differences exist, however, and these are described.

Official Publications Received.

Sixth Report of the Smoke Abatement League of Great Britain. Pp 17. (Manchester: 33 Blackfriars Street.)

Contributions to Palaeontology from the Carnegie Institution of Washington. Papers concerning the Palaeontology of the Pleistocene of California and the Tertiary of Oregon. (Publication No. 347.) Pp. iii+92+10 plates. (Washington: Carnegie Institution.)

Archaeological Investigations in the Aleutian Islands. By Waldemar Jochelson. (Publication No. 367.) Pp. ix+145+28 plates. (Washington: Carnegie Institution.)

United States Department of Agriculture. Department Bulletin No. 1339. The Effect of Weather upon the Change in Weight of a Colony of Bees during the Honey Flow. By James I Hambleton. Pp 52. (Washington: Government Printing Office.) 10 cents.

Livingstone College. Annual Report and Statement of Accounts for the Year 1924–25. Pp 24. (Leyton, E.10.)

New Zealand: Department of Lands and Survey. Scenery Preservation: Report for the Year ended 31st March 1925, together with Statement of Accounts and Schedule of Lands acquired and reserved during the Year under the Scenery Preservation Act. Pp. 7. (Wellington, N Z.: W. A. G. Skinner.) 6*d*.

Transactions and Proceedings of the Botanical Society of Edinburgh. Vol 29, Part 2, Session 1924–25. Pp. xvi+119-217. (Edinburgh.) 7*s*. 6*d*.

Proceedings of the Royal Society of Edinburgh. Session 1925–1926. Vol 46, Part 1, No 1: Some Modern Aspects of Physical Research. Address by the President, Sir Alfred Ewing. Pp. 8. 9*d*. Vol. 46, Part 1, No 2: Prenatal Death in the Pig and its Effect upon the Sex-Ratio. By F. A. E Crew. Pp. 9-14. 6*d*. (Edinburgh: R Grant and Son; London: Williams and Norgate, Ltd.)

Communications from the Geological Institute of the Agricultural University, Wageningen (Holland). No 9. Report on a Collection of recent Shells from Obi and Halmahera (Moluccas). By Dr. C H. Oostingh. Pp 363. (Wageningen: H. Veenman en Zonen.)

New Zealand. Dominion Museum. Bulletin No 9. Maori Agriculture; the Cultivated Food Plants of the Natives of New Zealand, with some Account of Native Methods of Agriculture, its Ritual and Origin Myths. By Elsdon Best. Pp viii+172+27 plates. (Wellington, N Z.)

Forest Bulletin No 67 (Silviculture Series). Chir (Pinus longifolia) Seed Supply. By S H. Howard Pp. 7. (Calcutta: Government of India Central Publication Branch.) 3 annas, 4d.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia Verhandelingen No 14. Regenval in Nederlandsch-Indie (Rainfall in the Netherlands Indies). Door (by) Dr. J Boerema. Deel 1 (Vol. 1): Gemiddelden van den Regenval voor 3715 Waarnemingsplaatsen in Nederlandsch-Indie, berekend uit Waarnemingen verricht in het Tijdvak 1879–1922 (Mean Rainfall Figures for 3715 Rainfall Stations in the Netherlands Indies, calculated from Observations made during the Period 1879–1922). Pp viii+192 (Weltevreden: Landsdrukkerij)

The American Museum of Natural History. Guide Leaflet No 61: The Capture and Preservation of Small Animals for Study. By H. E Anthony Pp 53 (New York) 15 cents

Diary of Societies and Public Lectures.

SATURDAY, January 9.

Geographical Association (Annual Meetings) (at London School of Economics), at 9.30 a m —Exhibition —At 10.—Prof. P. M Roxby The Concept of Natural Regions in the Teaching of Geography, with Special Illustrations from China —At 11.15.—Discussions held concurrently in separate rooms —C G. Beasley and others: The Place of Geology in a Two Period a Week Geography Course —C. D. Forde and others Detail in Geography Lessons —Major A. G Church and others: Geography in Relation to other School Subjects.—Miss R. M Fleming and others: Geography for the Younger Children in Primary Schools.

Institution of Municipal and County Engineers (Yorkshire District) (at Town Hall, Huddersfield), at 2.30

Royal Institution of Great Britain, at 3.—Sir William Bragg: Old Trades and New Knowledge: (6) The Trade of the Miner.

Institute of British Foundrymen (Lancashire Branch) (at College of Technology, Manchester), at 4 —J. Longden Liquid Shrinkage in Grey Iron.

MONDAY, January 11.

Royal Irish Academy, at 4.15.

Royal Society of Edinburgh, at 4 30 —Prof. A A. Lawson. Endemism and Evolution as observed in the Australian Flora.—Prof. G. Harrower A Study of the Hokien and Tamil Skull —Dr D A Fairweather Electrosynthesis in the Series of Normal Dibasic Acids —Miss C C Miller The Slow Oxidation of Phosphorus Trioxide, Pt I. The Action of Water Vapour on Phosphorus Trioxide —E T. Copson: Partial Differential Equations, and the Calculus of Variations

Victoria Institute (at Central Buildings, Westminster), at 4.30 —Prof. T G. Pinches. Notes on the Discoveries at Ur and Tel Al-Obeid, and the Worship of the Moon-God.

Institution of Automobile Engineers (Birmingham Centre) (at Chamber of Commerce, Birmingham), at 7 —H. Briggs: The Elimination of Noise in the Motor Cycle.

Institution of Electrical Engineers (Informal Meeting) (at University College), at 7.—W C. Clinton and others Discussion on The Electrical Installation at the Rockefeller Building, University College.

Institution of Electrical Engineers (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.

Institution of Mechanical Engineers (Graduates' Section, London), at 7 —E. H. Lewis. The Reduction of Factory Costs

Institute of Metals (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—Prof F C Thompson: The Mechanical Properties of Non-Ferrous Metals and Alloys at High Temperatures

Surveyors' Institution, at 8 —W. L. Taylor: Recent Forestry Development.

Royal Geographical Society (at Æolian Hall), at 8.30 —J. P. Mills: The Assam-Burma Frontier.

Royal Society of Medicine, at 8.30.—Prof. Noel Paton. The Metabolic Changes in Chloroform Poisoning.

Institute of Brewing (London Section) (at Engineers' Club, Coventry Street, W) —J. Stewart Barleys.

Institution of Electrical Engineers (Western Centre) (at Swansea) —R A. Chattock. Presidential Address.

TUESDAY, January 12.

Manchester Geological and Mining Society, at 4.

Royal Society of Medicine (Therapeutics and Pharmacology and Medicine Sections), at 5 —Prof. Elliott and Prof. Cummins and others Discussion on The Treatment of Pulmonary Tuberculosis with Sanocrysin

Institution of Petroleum Technologists (at Royal Society of Arts), at 5 30 —J. Stanley Lewis: The Vapour Pressures of Fuel Mixtures, Part II, to be followed by a discussion, opened by Prof J. S S. Brame, on The Estimate of Unsaturated and Aromatic Hydrocarbons.

Institution of Civil Engineers, at 6 —C. F. Bengough: High Level Bridge, Newcastle-upon-Tyne Underpinning and Repair of Foundations of River Piers.

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.

Institution of Electrical Engineers (Scottish Centre) (at North British Station Hotel, Edinburgh), at 7.—H. M. Sayers: Electricity Supply Tariffs.

Royal Photographic Society of Great Britain, at 7 —A S. Watson. The Influence of the Renaissance on Italian Painting.

Institution of Automobile Engineers (Coventry Centre) (at Broadgate Cafe, Coventry), at 7 30 —J D Parkes Logic applied to Failures

Society of Chemical Industry (South Wales Section) (at Technical College, Cathays Park, Cardiff), at 7.30.—Discussion on The Training of Chemists for Industry.

Institution of Engineers and Shipbuilders in Scotland (at 39 Elmbank Crescent, Glasgow), at 7.30.—Prof. W. Kerr: Failure of Metals by Creep.

Quekett Microscopical Club, at 7 30.—T. Savory Evolution in Spiders

Pharmaceutical Society of Great Britain, at 8 —F Browne and Dorothy G. Randle. Some New, Modified and Tested Formulæ of the British Pharmaceutical Codex.

WEDNESDAY, January 13.

Royal Society of Arts, at 3 —Prof H. E. Armstrong. Alice in Wonderland at the Breakfast Table (Mann Juvenile Lectures) (2)

Royal Society of Medicine (Surgery: Sub-Section of Proctology), at 5 30 —Dr. C. Dukes. Simple Tumours of the Large Intestine and their Relation to Cancer. (To be followed by a discussion)

Institution of Civil Engineers (Informal Meeting), at 6 —F. J. Price The Testing and Examination of Materials for Railway Construction.

Radio Society of Great Britain (Informal Meeting) (at Institution of Electrical Engineers), at 6.

Institution of Electrical Engineers (South Midland Centre) (at Birmingham University), at 7.—C. E. Webb: The Power Losses in Magnetic Sheet Material at High Flux Densities.

Institution of Chemical Engineers (jointly with Society of Chemical Industry (London Section)) (at Chemical Society), at 8.—A. J. V. Underwood: A Critical Review of Published Experiments in Filtration. —Dr. G Martin. Tube Mill Grinding—with special reference to Grinding in a Current of Air

Institution of Engineers-in-Charge (at St. Bride Institute, Bride Lane, E.C.), at 8 —J. W. L Rowe: Industrial Economics

Institution of Structural Engineers (Lancashire and Cheshire Branch) —Prof J Husband: The Lateral and Transverse Bracing of Bridges.

THURSDAY, January 14.

Royal Society, at 4 30.—Dr L. Hill and Y Azuma Effects of Ultra-Violet Radiation upon Involuntary Muscle and the supposed Physiological Interference of Visible Rays —L de B Daly: A Closed Circuit Heart Lung Preparation Effect of Alterations in the Peripheral Resistance and in the Capacity of the Circulation —*To be read in title only* —T S. P. Strangeways and Honor B. Fell. Experimental Studies on the Differentiation of Embryonic Tissues growing *in vivo* and *in vitro*. I. The Development of the Undifferentiated Limb-bud (*a*) when subcutaneously grafted into the Post Embryonic Chick, and (*b*) when cultivated *in vitro* —C N Long. Muscular Exercise, Lactic Acid, and the Supply and Utilisation of Oxygen Part XIV The Relation in Man between the Oxygen Intake during Exercise and the Lactic Acid Content of the Muscles —K. F Hetzel and C. N. Long. The Metabolism of the Diabetic Individual during and after Muscular Exercise —W G Millar: The Diffraction Method of measuring the Diameter of Erythrocytes

London Mathematical Society (at Royal Astronomical Society), at 5.

British Psychological Society (Education Section) (at University College), at 6.—Miss Margaret Drummond. The Nature and Training of the Imagination.

Institution of Electrical Engineers (Dundee Sub-Centre) (at University College, Dundee), at 7 30 —W. M Mackay. Atmospheric Electricity.

Institution of Mechanical Engineers (Glasgow Branch) (Annual Meeting) (at Royal Technical College, Glasgow), at 7.30.—S Couper Economy of Fuel in Steam Generating Installations

Institution of Mechanical Engineers (Cardiff Branch) (Annual Meeting).

Institution of Mechanical Engineers (Liverpool Branch) — Third Report of the Marine Engine Trials Committee.

Oil and Colour Chemists' Association.

Institution of the Rubber Industry (Manchester Section) (at Manchester) —H. C Young: Steam and its Control as applied to Rubber Production Methods.

FRIDAY, January 15

Royal Astronomical Society (Geophysical Discussion), at 5.—Prof J. Joly: Radioactivity and the Earth's Surface History Other speakers Dr H. Jeffreys and P Lake In chair—Lord Rayleigh.

Institution of Mechanical Engineers (Informal Meeting), at 7.—Discussion. Novelties at the 1925 Engineering Exhibition.

Royal Photographic Society of Great Britain, at 7 —A C Banfield and J D. Johnston Demonstration of Thiocarbamide Lantern Slide Making

Photomicrographic Society (at 30 Mortimer Street) (Members only), at 7 —J W Ogilvy: Demonstration of Recent Improvements in Microscopical Apparatus

Institute of Metals (Swansea Local Section) (at University College, Swansea), at 7.15.—Prof. F. C. Thompson: The Wire-Drawing Process

Junior Institution of Engineers, at 7 30 —J. Wolstenholme: The Commercial Side of Foundry Work

Institute of Metals (Sheffield Local Section) (at Sheffield University), at 7.30 —Prof C H Desch The Early History of Gold

Institution of Structural Engineers (Midland Counties Branch) (at Birmingham), at 7 30 —W. E. Ballard: Metallisation with special reference to Zinc Coatings to prevent Corrosion of Structural Steelwork

Institution of Mechanical Engineers (Leeds Branch) (Annual Meeting) —Prof. F. C. Lea: Repetition Stresses.

SATURDAY, January 16.

Scottish Junior Gas Association (at Royal Technical College, Glasgow), at 7 —D. Cairns: Paper.

PUBLIC LECTURES.

MONDAY, January 11.

Dyers' Hall (Dowgate Hill), at 6.—C. M. Whittaker: Artificial Silk Dyeing

FRIDAY, January 15.

University College, at 5 —Prof T Borenius Donatello.

SATURDAY, JANUARY 16, 1926.

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Research and Education in Agriculture.

IT is difficult for the lay mind to appreciate the possibilities of an architectural venture until at last the scaffolds are withdrawn and the finished building stands forth for all to see—to praise or to blame. It has been thus with the steady building up of our present system of agricultural research and education. It is only now, as the scaffolds are being slowly removed, that we can realise to the full the scope of the edifice which it has been sought to erect.

The Report recently issued by the Intelligence Department of the Ministry of Agriculture[1] is an interesting document, in which it has been possible perhaps for the first time to give the reader a complete picture of the machinery by which it is hoped to bring scientific knowledge and scientific method to the direct aid of the farmer. It will be a matter of surprise to many—no doubt accustomed to think that England still lags far behind other countries in the matter of financial support to agricultural research and education—to find on what a substantial foundation the system has been built. The plans, too, have been well drawn, for they allow of harmonious expansion in several directions, and there can be no gainsaying that the system as a whole holds much promise for the future.

It will be apparent that one of the corner-stones of the whole structure is research—and it is satisfactory to be able, in parenthesis, to add that the farmers themselves have been second to none in their anxiety that this stone should be well and truly laid. Not only are annual grants to a total exceeding 104,000*l.* made to twenty-one research institutions in England and Wales—each charged with definite lines of inquiry—but also grants now amounting to 31,400*l.* are made to fourteen advisory centres in order largely to provide for research into purely local problems.

It is very satisfactory to note that the advisory system has been considerably strengthened—the grants have been increased by 13,650*l.* since 1921–22, and advisory economists have now been appointed to the majority of the centres. Perhaps the chief merit of the advisory scheme is the tacit recognition of the importance of stimulating the research spirit in connexion with the teaching departments. It follows that a far-reaching effect of the strengthening of the personnel at the colleges consequent on the appointment of the advisory officers is that the teaching staff have greater opportunities for specialisation and for conducting independent research.

Grants to agricultural departments of the universities and to agricultural colleges for higher education are made to fifteen institutions to a total of 48,500*l.* There is less disparity between the grants made to the different teaching centres—although even here it is appreciable—than to institutions charged primarily with research. In the latter case a large disparity is almost inevitable, since the several research institutions have very different terms of reference demanding very different staffing and equipment. As time goes on it is, however, to be hoped that it will be found possible rather to level up the grants to the several institutions than to accentuate the differences further—and this tendency should be applied alike to research and educational grants. Over-wide disparities in the distribution of public funds are at all times undesirable, and if carried to excess might possibly stimulate something much less desirable than healthy rivalry.

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[1] Ministry of Agriculture and Fisheries. Report of the Work of the Intelligence Department of the Ministry for the three years 1921–24 Pp 163. (London: H.M. Stationery Office.) 5s net.

Grants to the counties have totalled 150,000*l.*, making the gross expenditure on county work, in part financed from local funds, 224,000*l.* Agricultural organisers are now attached to practically all the counties in England and Wales, while in a large number of counties there also exists the nucleus of a sound educational staff. The provision of farm institutes in the counties has been increased to fourteen.

There is thus provided a complete chain from research to education aiming at bringing the maximum of assistance to the farmer. The organisation of the whole system, however, presents difficulties, for not only are a large number and wide range of workers involved, but administration also falls to a number of different bodies—the Ministry of Agriculture, the governing bodies of colleges, universities and research institutions, and the county authorities. In regard to some aspects of the work responsibility is also, in part at least, delegated to advisory committees or councils, while trade interests and opinions have frequently to be considered.

The Ministry of Agriculture has sought to coordinate the whole work by setting up standing conferences, such as, for example, those of the advisory pathologists and advisory chemists, and from time to time calling larger conferences of research, college, and county workers. Regional conferences of all the workers in the counties associated with the different advisory centres have also become general, and more and more are fulfilling the most important part in the smooth working of the machine. There is perhaps real risk, however, that some of the measures adopted may tend towards a too great standardisation in respect of the functions and duties of both institutions and individuals, rather than towards co-ordination in the highest sense.

In research a certain amount of overlapping can never be avoided, and since method and individuality go for so much, is perhaps rather to be encouraged than the reverse. The consequences could only be disastrous if research came to be considered as almost the sole prerogative of the research institutions and of the advisers, and if the drawing up, or criticism, of schemes of research or inquiry were deemed only to be the concern of the "official" research workers. In a loosely knit together system the success of which depends solely on good-will—and since the system is primarily intended to serve the interests of a profoundly complicated industry—the ideas of practical workers in close touch with the farmer should be regarded as of at least equal value in formulating profitable lines of research to those of the research workers themselves.

It is, therefore, of the utmost importance that the constitution of all conferences and committees—if only remotely connected with the administration of any part of the scheme—should always be such as to imply nothing in the nature of prerogatives. Moreover, the terms of reference under which an institution or an individual worker acts, no matter how restricted their scope, are surely not intended to imply the possession of a monopoly; consequently—and in order to dispel completely the possibility of any such views being held—the greatest possible encouragement should be given to any independent worker of proved capacity to proceed with an attack by methods which seem good to him on a problem to which he is attracted, even if the investigation comes within the category of subjects dealt with at one of the research institutions. Any tendency in the opposite direction should be rigidly guarded against, for if allowed to develop it would assuredly shatter the stability of the whole fabric, and would certainly tend to stultify originality, which is the life-blood of successful investigation.

There is very considerable evidence in the report to show that scientific information is, in fact, not only being put into the farmers' hands, but is also being used to good advantage. Perhaps the most significant figure quoted in this connexion is that 6782 persons attended evening classes during the year 1923–24, while the success of the formation of agricultural discussion societies in the counties is another excellent augury for the future. The value of these classes and societies will, moreover, increase in proportion as the number of young men with practical farming as their objective pass through the colleges and farm institutes.

The various schemes of organisation pressed forward by the Ministry have amply justified themselves. This is well seen with reference to the recent great advances made in poultry keeping in Great Britain and in relation to various aspects of the horticultural industry. In some ways the most significant work of organisation is that connected with certain features of the administration of the Destructive Insects and Pests Act. Reference is made to the inspection and certification of growing crops of approved immune varieties of potatoes and to the wart disease immunity trials conducted under the auspices of the National Institute of Agricultural Botany at its Ormskirk station. These constitute relatively new departures, which eventually will almost certainly be applied in principle to other crops with beneficial results of a magnitude that at present we can but dimly foresee.

By no means the least important of the activities under the general guidance of the Ministry are the various live-stock improvement schemes. The report before us is evidence in particular of the fruitful results of the comparatively recently introduced milk-recording scheme. The recorded herds show a substantial increase in the average yields per cow from year to year, and, what is of greater importance, a marked improvement in the proportion of high-yielding cows in the several herds, due to the steady weeding out of the poorer milkers. This is a scheme which has an altogether greater value than is indicated merely by the convincing statistics given—for more than any other educational activity it has taught the farmer the value of accurate records, a lesson which he must come eventually to apply to all his breeding and perhaps to most of his practices.

From the scientific point of view, the achievements have important implications, for they show the necessity of testing and checking the validity of show-yard criteria in respect of all live-stock. At present the breeding societies, assisted by the Ministry, base the selection of sires almost wholly on show-yard criteria, and the excellence of the selections made is sought to be substantiated in a paragraph—which is perhaps prematurely thrasonical—alluding to the successes of stock by premium bulls at the shows.

The whole question of the merits of one breed compared to another, and of one type of animal within the breed to another, is intimately connected, however, with economy of conversion of feeding-stuffs. It would perhaps be wise, in view of the teaching of the milk records, to initiate well-planned local schemes of experimentation, at carefully selected centres, designed to obtain trustworthy data on the economic suitability of different types of animals for the different conditions obtaining. This should be done before going too far to encourage breed societies run on the unproven assumption that show-yard criteria afford the correct basis for selecting sires competent to beget progeny with the highest possible money-earning capacity when employed as ordinary farm stock in the districts severally served by the societies.

The History of Engineering.

A History of Engineering. By A. P. M. Fleming and H. J. Brocklehurst. (The Histories of English Industries Series.) Pp. vii+312. (London: A. and C. Black, Ltd., 1925.) 12*s*. 6*d*. net.

THOUGH there are many biographies of engineers and historical works in various branches of engineering, no attempt appears to have been made to write a general history of engineering. The reasons for this are perhaps not far to seek. No one but an engineer could write such a book, and engineers, as a rule, are actively engaged in the exercise of their profession and are concerned more with the present and the future than with the past. It is true many engineers possess the necessary literary ability and a few the wide knowledge and experience, but the opportunities for historical studies are but few. A step in the right direction was taken a few years ago when the Newcomen Society was founded, and the researches by its members will prove a mine of information for the future historian. But the subject is a vast one; the materials are there in profusion, and the task of selection is by no means easy. Of the sources of information, none are perhaps of more value than the transactions of the various engineering societies, the addresses of the presidents often containing historical reviews of great importance; those of Sir John Rennie in 1846 and of Sir William White in 1903 to the Institution of Civil Engineers being two notable examples.

While no general history of engineering exists, historical notes are often given in text-books, and there is ample evidence that in the profession there is a growing sense of the value of the records of the past. France and England have possessed museums illustrating invention and engineering for many years, German engineers supported whole-heartedly the building up of the Deutsches Museum in Munich, and energetic action is now being taken to form a National Museum of Engineering and Industry for the United States. This will probably take the form of a central museum at Washington, with smaller museums of an educational character in some of the great industrial centres. This is a movement which will be watched with growing interest. The committee entrusted with the task of inaugurating the American Museum includes representatives of the four Founder Societies of Civil Engineers, Mechanical Engineers, Mining Engineers, and Electrical Engineers. For their president they have Mr. Samuel Insull, of whom it has been said "no ship ever stranded which had him for its helmsman."

Nearly all engineering can be included in four groups relating to transport, communication, power, and production. The story begins with the earliest of tools, the making of sledges and the use of metals. It includes the construction of canals and harbours, bridges and aqueducts by the Chinese, the Egyptians, and the Romans, who, working with the simplest appliances, raised those monumental works which claim our profound admiration to-day. While admitting the absorbing interest of the study of the engineering feats of the ancients, it is modern engineering which has changed the face of the world and the habits of nations. Modern engineering had its birth with the steam engine in the early part of the eighteenth century, and its scope is indicated by the definition accepted after much deliberation by the American Society of Mechanical Engineers in the statement: "Engineering is the science of controlling the forces and utilising the materials of nature for the benefit of man and is the art of directing and organising human activities in connexion therewith." The definition breathes a spirit of service worthy of the noble heritage of the engineer; a heritage of which we cannot know too much. Each generation has produced its pioneers, and the young engineer will find in their lives a source of inspiration. The objects of our engineering museums include the preservation of historic works, but they might also well include the publication of adequate and impartial histories of the progress of engineering.

Like all science, engineering is international, and the improvements and discoveries of each nation are available for all. Yet there is room for the histories of nations as well as of mankind, and the book which has led to these remarks is a history of engineering devoted mainly to the story of engineering in England. It has chapters on docks and harbours, canals, roads and bridges, steam, railways, iron, gas and electricity, as well as a short chapter on ancient engineering. The writers, however, have mainly kept to the old well-beaten tracks, and we are thus once again brought into the company of Brindley, Newcomen, Stephenson, Cort, Watt, Hedley, and Faraday. The story retold is of immense importance, but we should have been glad of more information regarding the growth of the great industries these pioneers promoted. Of thirty-four pages given to the chapter "The Age of Steam," thirty are devoted to Savery, Newcomen, Watt, and their contemporaries, and four to the steam turbine. We nowhere find the names of Perkins, Donkin, Hicks, Joule, Marshall, Elder, Kirk, Rankine, Willans, or Yarrow. The compound and triple expansion engines, the high-speed engines working with high pressures, were all very important improvements, and half a century ago numerous engineering firms were employed almost solely in their production. We were the makers of steam engines for the whole world, and the history of this industry has never been written.

As introductory essays to the study of engineering history, the sketches in the book are well worth reading, but much more is required than this. The sense of proportion is one of the essential qualifications of the historian of engineering if he is to endeavour to follow in the footsteps of Gibbon, who with a wide and intimate knowledge of his subject possessed the power of mastering his materials and of condensing them into a broad and well-filled narrative in a manner which has never been surpassed. We speak of the age of steam, the iron age, the steel age, the age of machinery, the age of electricity, and the age of invention, but there are no such separate ages; they are all included in the age of modern engineering, and the telling of that story still awaits its Gibbon.

The Psychology of Juvenile Crime.

The Young Delinquent. By Prof. Cyril Burt. Pp. xx+643. (London: University of London Press, Ltd., 1925.) 17*s.* 6*d.* net.

PROF. BURT'S aim in this important study is primarily practical; he wishes to afford to teachers, probation officers, and others, aid in the investigation and treatment of young offenders. His practical advice, however, is based upon an exact and scientific study of data collected by himself in the course of his work in connexion with the schools of the London County Council, and he brings to bear upon the treatment of his problems a breadth of outlook very rare in the previous studies of the etiology of crime. Very frequently these have been vitiated by over-emphasis of selected cases, by preconceived notions as to the relative importance of heredity and environment as determinants of human conduct, by the absence of a sound anthropological and psychological basis.

Prof. Burt's work undoubtedly avoids these defects. His method is to take a sample collection of two hundred consecutive cases of juvenile delinquency, to study these intensively, and to check his conclusions by a study of a control group of four hundred cases taken from the non-delinquent population of children of the same age and social class, living in the same streets and attending the same schools. In each case he studies carefully the home circumstances, the family history, the physical and mental condition of the child concerned. His main conclusions may be briefly indicated. As to hereditary factors, he shows that the notion that crime can be as such inherited is due to crude and antiquated ideas as to the existence of an innate moral sense, and to the fact that most writers on the subject have adopted the method of citing conspicuous case histories and selected family trees with crime occurring in all of them. His own elaborate statistical study shows that cases of sporadic crime are far more usual than those with criminal lineage. It is true that intellectual and moral defects have a high frequency among delinquent families, but the figures given approach closely those for defective discipline and vicious surroundings, and it is therefore possible that we are dealing rather with contagion than biological heredity. We shall see later that a direct hereditary relation is asserted of crimes based upon an exaggeration of certain instincts. But even in these cases the instincts underlying them are not as such criminal and are never the sole causes of the crimes committed. All that can be said at the most is that what is inherited is a vague congenital enfeeblement which may affect the temperament, intelligence, and physique as a whole, and may in certain circumstances find expression in tendencies to crime.

It is one of the many merits of Prof. Burt's work that he avoids any undue separation between environmental and hereditary factors. It is not any given situation or environment that makes a man a criminal, nor is crime due to hereditary structure or equipment taken in itself. In all cases we have to deal with a subtle and intricate personal response to a given situation. Such response is never merely mechanical, never a passive effect of an external cause, but the active expression of the mind of the individual in relation to his environment. It is necessary, accordingly, to study both the innate equipment and the environmental condition of the criminal, but the two sets of factors must not be sharply separated from one another and pitted against one another in the simple manner so common in the literature of the subject. Moreover, in regard to the environmental factors, it must be remembered that owing to their complexity they can scarcely ever be fully and adequately determined, and that though, for purposes of investigation, each factor may be studied in abstraction from the rest, yet in fact they interact and modify one another in the most intricate and perplexing manner.

The use of mathematical or statistical expressions often gives to results of social inquiry an appearance of precision quite unwarranted by the crude data upon which they are commonly based. Prof. Burt uses his statistical methods with the caution which we have learnt to expect from him. The coefficients of association he arrives at for environmental factors are: for poverty, 0·15; for defective family relationships, 0·33; for vicious homes, 0·39; for defective discipline, 0·55; for conditions outside the home, including unemployment, uncongenial work, influence of associates, 0·29. He shows clearly that the commonest and most disastrous conditions are those that centre about the family life. As regards physical characteristics, Prof. Burt confirms the conclusion, reached by Goring in relation to adults, that the criminal conforms to no definite physical type. On the other hand, defects of development and general physique are more common among delinquent than among non-delinquent children of the same class. In general intelligence delinquent children have a lower average mental ratio than the non-delinquent. More serious is the fact that the "educational ratio" of the former which measures their attainment as distinguished from their ability is only 81 per cent., that is, at the age of ten their attainments are on an average those of a child of eight, and that of those who have left school, more than half are under the level of Standard V.

The least satisfactory portion of the book seems to me to be that devoted to the study of the temperamental conditions of crime. Prof. Burt finds a correspondence between categories of delinquencies and the usually accepted classifications of instincts, and this leads him to stress the instinctive origin of certain types of crime, especially those connected with sex, violent temper, wandering, and impulsive theft. But there is, as I think, at present too much divergence of opinion both as to the nature and classification of human instincts to make such a treatment really fruitful. Some examples will make this point clear. Prof. Burt studies cases of theft in connexion with the instinct of acquisition, but it may be and has been seriously doubted whether acquisition in man is really instinctive. The processes of acquiring are generally connected with the satisfaction of other instincts, for example, nutrition and sex, and objects connected with these and other instincts may by well-known psychological processes of assimilation and acquirement of meaning come to have value attached to them. Cases of so-called "objectless" hoarding can generally be shown by analysis to have an interest real enough to the subject concerned, though meaningless to the external observer.

So again, I doubt whether self-assertiveness and self-submission can be correctly spoken of as instincts. They seem to indicate rather degrees of strength with which the instincts generally express themselves in different individuals. If this be so, the explanation of cruelty given by Prof. Burt as due to an exaggeration of the instinct of assertiveness is only true in the sense that the intensification of any instinct, notably of combativeness and sex, may lead to a condition of absorption causing disregard of the pain of others. Again, to assert that sex-differences in relation to crime are connected with the different strengths of the instincts in the two sexes seems, in the present state of the psychology of the instincts, weak methodologically. For example, the explanation suggested on these lines of the greater frequency of cases of theft among boys than among girls, would have been better grounded if Prof. Burt had been able to produce independent evidence to show that women are innately less acquisitive than men. One conclusion certainly emerges from this discussion, namely, the urgent need there is at present for a really scientific classification of the human instincts. The volume before us is the first of a series of three. The other two will be eagerly awaited by all students of social science and education. MORRIS GINSBERG.

The Structure of the Earth.

Der Aufbau der Erde. Von Dr. B. Gutenberg. Pp. viii + 168. (Berlin: Gebrüder Borntraeger, 1925.) 9 gold marks.

THE work under review is a general survey of the known results relating to the condition of the interior of the earth. In most cases the theories discussed are not developed in detail, but summaries of the data and the main conclusions are given. Accordingly a very large amount of material has been compressed into a small space. It may be said that the main use of the book is to facilitate reference to original investigations; in this the reviewer speaks from his own experience. Perhaps the greatest difficulty that besets geophysics is that its literature is scattered through so many periodicals. It is easy to think of eight British journals that have contained important geophysical (apart from meteorological) papers during the past ten years, but in Germany the confusion is even greater. The bibliography in this book refers to twenty papers by the author himself, in nine periodical and several non-periodical publications; and the total number of German periodicals including geophysical papers is such that some convenient summary, with references, such as Dr. Gutenberg's book affords, is essential to any one wishing to know what work has actually been carried out. Unfortunately there are signs of insufficient verification; near the beginning of the bibliography we find "Cooker" for "Coker," without indication that the associated Adams is F. D. and not J. C. or L. H.; and incorrect initials are then attributed several times to L. H. Adams. But the labour involved in compiling a 14-page bibliography in the circumstances must have been enormous, and the author deserves our gratitude, especially as he has done justice to countries and languages not his own.

The seismological parts of the book merit the greatest attention. The illustrations on pp. 7, 8, 25, 30, and 96, showing typical seismograms for various epicentral distances, are a valuable feature. Accounts are given of the determination of the wave-velocities at various depths from the times of transmission, and also of Zöppritz's method of amplitudes, the actual application of which is largely due to Dr. Gutenberg. If the velocity of a compressional wave, say, increases steadily with depth, the amplitude of the motion it produces on emerging at the surface will vary smoothly with distance from the origin; but if the rate of increase of the velocity with depth changes suddenly, the amplitude will also change suddenly. As a rule, observations of the same shock at many stations are not collected, and use was made, instead, of the ratios of the amplitudes of the primary and first reflected waves for different earthquakes; this plan has obvious drawbacks, but it has the advantage that all the observations were made on the same instrument. The method is very sensitive, and its use probably lies mainly in filling in the finer details of the variation of velocity, the times of transmission giving the general outline. A rather sudden decrease of the velocity of the compressional waves, at a depth of about 0·6 of the radius, was inferred from the time-curves by R. D. Oldham in 1906. Gutenberg shows that this is confirmed by the smallness of these waves for distances of 110°-140°, while their reappearance at minimum deviation is indicated by the large amplitudes found at about 140°. That the central core below this depth is truly fluid is indicated by the absence of distortional waves at greater distances.

An account is given of the "individual P-waves" of A. and S. Mohorovičić—compressional waves from foci within the outer granitic layer, which travel directly from the focus to the surface, whereas the normal P-wave travels down to the basic rocks below and up again. These and explosion waves give valuable information about the surface layer, and the author then discusses the surface waves at length. The estimate of the thickness of the surface layer based on these last is, however, vitiated by a confusion between wave-velocity and group-velocity.

Other chapters deal with the figure of the earth, the internal distribution of density, chemical composition, the cooling of the earth, and the structure of the atmosphere. The age of the earth and tidal friction are not discussed, but the bodily tide is considered at some length. The author has misunderstood the situation with regard to the explanation of the annual variation of latitude, for he suggests that the work of the present reviewer on this subject was an attempt to improve on that of Schweydar, which was already perfect. Actually my work was published in 1916, Schweydar's in 1919 (of course, independently), and in both there remains a considerable discrepancy between theory and observation.

Dr. Gutenberg's book is an important contribution to geophysics, both for its own content and for the aid it gives in the search for other literature.

H. JEFFREYS.

Our Bookshelf.

The Dinoflagellates of Northern Seas. By Dr. Marie C. Lebour. Pp. vii + 250 (35 plates). (Plymouth: Marine Biological Laboratory; London: Dulau and Co., Ltd., 1925.) 12*s.* 6*d.* net.

A SHORT account is given of the general morphology of the Dinoflagellata, in which the terms afterwards employed are clearly explained, the various modes of nutrition are considered, and notes are added on the reproduction and habits. Dr. Lebour expresses the opinion that a large proportion of what are now regarded as species may prove to be merely phases in the life-history of other species. An outline classification showing the families and genera precedes the systematic account, in which a short description of each genus and species is given, and the characters of the species are illustrated by one or more line drawings—those on the 35 plates being original. The methods of collecting and examining dinoflagellates are briefly described, a list of memoirs on the sub-class is appended, and there is a full index.

Dr. Lebour set herself the task of making as complete a survey as possible of the dinoflagellates which are known to occur in northern seas, and she has accomplished the work in a highly successful and critical manner. Her memoir will be warmly received by all who are interested in these organisms.

Kelvin the Man. A Biographical Sketch by his Niece, Agnes Gardner King. Pp. xv + 142 + 12 plates. (London: Hodder and Stoughton, Ltd., 1925.) 7*s.* 6*d.* net.

BY the many admirers of Lord Kelvin this book will be welcomed. In 1910, Silvanus Thompson wrote the official biography. In the preceding year, Kelvin's sister, Mrs. King, wrote "Lord Kelvin's Early Home," which gives a delightful picture of him from childhood to adolescence as a member of a singularly gifted and harmonious family. Silvanus Thompson says that he purposely abstained from trenching on that narrative, which brings the story of Lord Kelvin's life to 1849. The gap in the story of his personal and family life from 1849 onwards is now filled up by this book written by his niece, Agnes Gardner King She presents a very pleasant home picture of the great physicist, showing a very human and lovable side of his character. In the introduction, Sir Donald MacAlister says: "The testimony of an eye-witness in intimate touch with his home, and capable of putting down in simple and vivid words what she saw and heard, will crown as with a garland of home-grown flowers the Centenary Memorial raised to his scientific fame."

Intermediate Light. By Dr. R. A. Houstoun. Pp. x + 228. (London: Longmans, Green and Co., 1925.) 6*s.*

ENCOURAGED by the favour shown by advanced students to his "Treatise on Light," Dr. Houstoun has now produced an elementary book on the same subject. It is broadly of University Intermediate or Higher Certificate standard, but the author, it is pleasant to note, is at no pains to conform to the syllabus of any particular examination. The book, therefore, contains matter seldom found in the ordinary elementary textbook. Colour and colour vision, for example, claim more space than is customary, and the historical references are both less meagre and less stereotyped than usual. At the same time, examination requirements are by no means overlooked, and a collection of questions from various public examinations forms a useful appendix. Other noteworthy features are the numerous and well-planned practical exercises and the new illustrations of familiar principles which are selected whenever possible. The diagrams and production are excellent; in fact, we have noticed nothing more reprehensible than a split infinitive There is no doubt that the book deserves and will enjoy a wide popularity.

Prof. Dr. Paul Pfurtscheller's Coloured Zoological Wall-Plates. Plate 32: The Common Gnat (*Culex pipiens*). Insecta, Diptera II. 4 ft. 8 in. × 4 ft. 3 in (London: W. and G. Foyle, Ltd.; The Hague: Martinus Nijhoff, 1925.) Unmounted, 10*s.* 6*d.*; mounted, with rollers, 16*s.*; mounted, with rollers, varnished, 17*s* 6*d.*

THIS is an excellent plate, lithographed in colours, illustrating the external features of the larva (from the dorsal aspect) and the pupa and the female winged gnat (as seen from one side). The important features are clearly displayed, the parts being skilfully arranged so as to exhibit as much as possible. A portion of the wall of the abdomen of the imago is shown cut away to permit representation of parts of the stomach, intestine, Malpighian tubes and ovary. In the fourth figure the head of a female and the mouth parts are drawn on a larger scale. It is ungracious to ask for more on such a full plate, but a drawing of the head of a male would have been helpful for comparison with that of the female.

Bacteriology. By Prof. Carl H. Browning. (Home University Library of Modern Knowledge.). Pp. 256. (London: Williams and Norgate, Ltd.; New York: Henry Holt and Co., 1925.) 2*s.* 6*d.* net.

WE think that Prof. Carl Browning has been extraordinarily successful in presenting a general outline of the principal facts concerning bacteria in a simple and concise manner suited to the general reader. The whole range of bacteriology is dealt with—history, the microscope, methods of investigating bacteria, and their rôle in Nature and in the causation of disease. Subjects such as antitoxins and the toxin-antitoxin reaction, complement fixation, the Weil-Felix agglutination reaction in typhus fever, ultra-microscopic organisms, the bacteriophage, immunity and chemotherapy, are all considered, and their presentation is such that any one reading the accounts of them will have a very good general idea of what they are and mean.

Geometry for Beginners, as far as the Theorem of Pythagoras. By J. G Bradshaw. Pp. vii + 99. (London: Longmans, Green and Co., 1925.) 2*s.* 6*d.*

IN many respects an excellent little book, in which blank pages are left for the pupil to insert his own proofs of the simpler propositions which are treated as riders. It is not in accordance with modern views, however, that beginners should be asked to learn the time-honoured proofs for congruence and parallels.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Further Studies of Sun-fishes made during the *Dana* Expedition, 1921-1922.

IN the columns of NATURE for March 17, 1921, I gave an account of the development of the sun-fishes so far as it was known up to that date, based on the investigations made during the first *Dana* expedition, in the course of which I was able to study the larvæ in a living state.

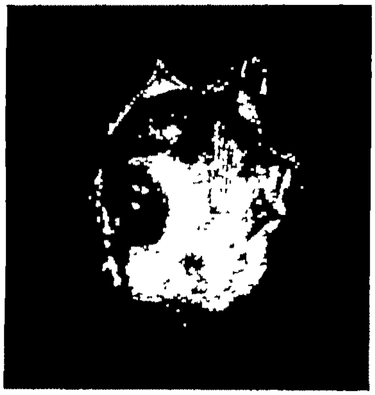

FIG. 1.—*Mola rotunda*, the short sun-fish. Specimen 5 mm. in length (*Dana*, St. 1238, 26° 13′ N., 78° 48′ W.).

The article described briefly the development of the two species, *Ranzania truncata* (the oblong sun-fish) and *Mola lanceolata* (the pointed-tailed sun-fish).

In a later and more detailed work, published by the Danish Commission for Investigation of the Sea ("Meddelelser fra Kommissionen for Havundersøgelser," Serie Fiskeri, vol. 6, No. 6, Copenhagen, 1921) I gave a further account of the development, and showed also that there are in the North Atlantic area *three* species of sun-fish: namely, in addition to the little Ranzania, not *one*, but *two* species of the large sun-fish proper (Mola), these being the ordinary tailless *Mola rotunda* (the short sun-fish) and the rarer form, *Mola lanceolata* (the pointed-tailed sun-fish) with a short tail.

Only one of the sun-fishes is common in the vicinity of Europe and in the Mediterranean, namely, the short sun-fish (*Mola rotunda*), which attains a length of from 8 ft. to 10 ft. or more, and a weight of more than a ton. The oblong sun-fish (Ranzania) has occasionally been found near the shores of Europe, but *Mola lanceolata* has never yet been met with in these waters, and only once, by Prince Albert of Monaco, in the open sea near the Azores.

To judge from the number of adult specimens known, *Mola rotunda* must, therefore, be by far the commonest species, *Ranzania truncata* less common, and *Mola lanceolata* very rare.

The *Dana* expedition (1920–22), however, reveals an entirely different state of things as regards frequency of occurrence, so far as the early developmental stages are concerned.

On the first *Dana* expedition, in 1920, we found, in the Sargasso Sea, eggs and early stages in great numbers, chiefly those of Ranzania, but also many of *Mola lanceolata*.

These stages, described in the issue of NATURE above mentioned, were found in such abundance in the Sargasso Sea that there can be no doubt but that this sea is a very important breeding-ground for both species. Of *Mola rotunda*, on the other hand, we found not a single specimen in the early stages. Here, then, we encountered a phenomenon not unknown to the marine biologist, to wit, the fact that species which are "rare" in the adult forms may be "common" in the larval stages, and vice versa.

On the second *Dana* expedition, 1921–22, we found the same thing again; here, however, in addition to many early stages of Ranzania and of *Mola lanceolata*, we also obtained a single specimen of *Mola rotunda*, 5 mm. long. It is possible that there may be one or two more specimens in the material, but up to now this is the only known early representative of *Mola rotunda*, the commonest or best known of all sun-fishes, and is therefore of no slight interest.

It is shown in the accompanying illustration, Fig. 1, and together with a specimen of *Mola lanceolata* of equal size, in Fig. 2. The great difference in appearance of the two is noticeable at a glance, without going into details. *Mola rotunda*, for example, lacks the enormous development of some of those spines which are peculiar to the early stages of sun-fishes, while on the other hand, the so-called eye-spines are rather more strongly developed in *Mola rotunda* than in *Mola lanceolata*.

Another feature of interest should also be noted. The larvæ of *Mola lanceolata* were, as mentioned, common in the Sargasso Sea, whereas of *Mola rotunda*, not a single specimen was found here; despite the fact that the *Dana* expeditions fished very intensively in these waters.

The only known early stage of *Mola rotunda* was found in a region west of the Sargasso Sea, where the expedition worked to a very slight extent compared with our operations in the Sargasso Sea, namely, at St. 1238 (26° 13′ N., 78° 48′ W.), about 20 miles south of Grand Bahama Island. *Mola lanceolata*, on the other hand, was not found here, but was taken at the subsequent stations east of Bahama (*e.g.* St. 1240 at 25° 35′ N., 74° 45′ W.).

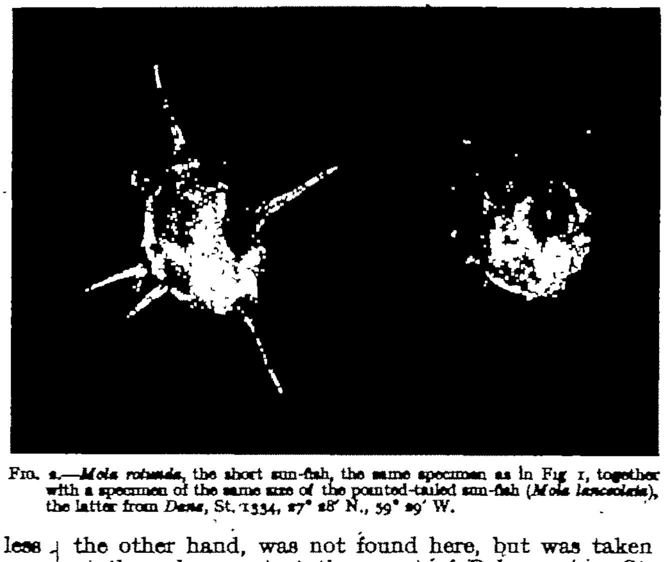

FIG. 2.—*Mola rotunda*, the short sun-fish, the same specimen as in Fig. 1, together with a specimen of the same size of the pointed-tailed sun-fish (*Mola lanceolata*), the latter from *Dana*, St. 1334, 27° 28′ N., 59° 29′ W.

So long as only a single specimen is known, it is of course impossible to say anything definite, but the question naturally suggests itself: May not the frequency of *Mola rotunda* as an adult form, in contrast to *Mola lanceolata*, on the shores of Europe, be primarily due to this very fact, that its spawning grounds lie farther west than the latter, rarer species, so that its larvæ would have more chance of being carried passively by the Gulf Stream and the Atlantic Current over to the European side ?

I have to thank Mr. Å. V. Tåning for undertaking the difficult task of photographing the specimens shown, and also for valuable assistance in other ways.

JOHS. SCHMIDT.

Carlsberg Laboratory,
December 2.

The Energy Levels of the Nitrogen Molecule.

IN a paper before the American Physical Society (*Phys. Rev.*, 23, 294, Feb. 1924) and in a letter to NATURE (Nov. 1, 1924, vol. 114, p. 642), I gave a set of electronic energy levels for the neutral nitrogen molecule, based on an analysis of its band spectra. These levels were designated *X*, *A*, *B*, *C*, and *D*, where *X* denotes the stable state of the molecule. The interval *X* to *A* was suggested as 65,000 (= 8·0 volts), the band system corresponding to this transition being as yet unknown. Dr. Sponer (*Zeitsch. f. Phys.*, 34, 622, 1925), by measuring the excitation potentials of various groups of nitrogen bands, has now obtained results in exact agreement with this diagram. The *X* to *A* interval comes out as 7·9 volts.

Duncan (*Astrophysical Jour.*, 62, 145, 1925) also has measured excitation potentials in molecular nitrogen. In discussing the theory he has stated that the 0–0 band of the second group (λ3371) should be excited at a potential higher than the 0–0 band of the first group (λ9108) by 2·3 volts. This, however, is incorrect. The difference should be 3·66 volts, corresponding to the frequency of the 0–0 band of the second group. However, the bands of the first group which he *actually observed* should be excited at about 2·0 volts less potential than the 0–0 band of the second group, in agreement with his actual results (10 and 12 volts respectively). With this correction, and with the assumption that all of his measured potentials are about 1·3 volts too low, there is agreement between his results and those of Dr. Sponer, as well as with my theoretical diagram. The only measurement by Duncan in error by more than his stated probable error is that for the weak fourth positive group.

As a result of my analysis of the nitrogen levels, I further stated that the carrier of the characteristic afterglow bands of active nitrogen was a neutral nitrogen molecule with 11·5 volts of energy (9·3 volts electronic and 2·2 volts vibrational) in excess of the stable state. The afterglow phenomenon was noticed by E. P. Lewis and the chemical activity associated with the afterglow was discovered some ten years later by Lord Rayleigh, who gave the name "active nitrogen" (see NATURE, Nov. 15, 1924, vol. 114, p. 717). As has been customary, I identified the carriers of the afterglow bands with the entity responsible for this chemical activity, and hence was forced to postulate that this molecule with 11·5 volts excess energy was in a metastable condition. Because this condition corresponded to the high vibrational quantum number eleven, there are grave theoretical objections to such an assumption, and Dr. Sponer now assumes that "active nitrogen" is atomic nitrogen. The recent work of R. W. Wood, Bonhoeffer, and others, on atomic hydrogen, and of Franck and his co-workers on "collisions of the second class," now make such an assumption not only possible, but plausible, even though the afterglow (a secondary effect of the *association* of atomic nitrogen) has been obtained with a duration of more than fifteen minutes (R. Rudy, *American Physical Society*, Nov. 1925). The full argument is given in her paper, to which reference has just been made, and leads directly to the conclusion that the 11·5 volts of excess energy of the carriers of the afterglow bands measures accurately the heat of dissociation of nitrogen.

After the emission of the afterglow bands, the excited nitrogen molecule is in state *A* and has 9·4 to 8·9 volts of energy. The bands corresponding to the transition *A* to *X* should lie in a spectral region where Prof. Hopfield and I later found a system of bands (NATURE, July 4, 1925, vol 116, p. 15), but this system gave progressions which, on the basis of the data then available, agreed with no other known progressions of nitrogen or of any other molecule. Using data which have recently become available, Dr. Sponer has now been able to classify this system, and her results are given in the accompanying letter.

RAYMOND T. BIRGE.

University of California,
December 5.

The Energy Levels of the Nitric Oxide Molecule.

IN a recent letter to NATURE (July 4, 1925, vol. 116, p. 15) R. T. Birge and J. J. Hopfield record the observation of a system of emission bands in nitrogen in the region of λ1854–λ1250. They found a formula for these bands that did not fit into the known level-scheme of nitrogen. This was a peculiar fact because the bands arising from the normal state of the N_2 molecule are to be expected in this region. The apparent discrepancy can now be explained by the discovery that these bands do not belong to the N_2 but to the NO molecule. This is quite possible, as the nitrogen used was not completely free from oxygen.

I am much indebted to Prof. J. J. Hopfield for giving me the opportunity to see the manuscript of an investigation by S. W. Leifson, on absorption spectra of different gases and vapours in the Schumann region (*Astrophysical Journal*, in press). By comparing the frequency differences of the NO bands of Leifson with those in the above-mentioned band system of Birge and Hopfield, I find that both systems have a common state. The final state of the absorption NO bands of Leifson is also the final state of the emission bands of Birge and Hopfield. Moreover, with the aid of new wave-length measurements of certain bands of the third positive group of nitrogen, kindly made for me by Prof. Hopfield from his plates, I find that the absorption bands of Leifson are merely the 0–0, 0–1, 0–2, etc., bands of the third positive group. Leifson's plates contain also the Birge and Hopfield bands.

Hence we have conclusive evidence that the third positive group belongs to NO, as has usually been assumed, and that its initial state in absorption is the normal state of the NO molecule, as Mulliken (NATURE, Sept. 6, 1924, vol. 114, p. 349) and Birge (*ibid.*, Nov. 1, 1924, vol. 114, p. 642) had suggested. The excitation potentials of the levels of the NO molecule can be given from these considerations as 5·44 and 5·44 + 8·52 = 13·96 volts; that is, 5·44 volts for the excitation of the 0–0 band (λ2269) of the third positive group, and 13·96 volts for the excitation of the 0–0 band (λ1450) of the Birge and Hopfield bands. From this it follows that the ionisation potential of the NO molecule must be greater than 14 volts.

I am glad to have had the opportunity to discuss these matters with Prof. R. T. Birge, and wish to thank him for his friendly co-operation.

HERTHA SPONER.

University of California,
December 5.

The Study of Taxonomic Zoology.

THE proper study of any aspect of zoology involves the consideration of the following facts: (1) the external world, in contradistinction to the organism, is undergoing constant and ceaseless change; (2) the organism itself is similarly subjected to change; (3) the organism and its environment are in a constant state of reaction. The physical sciences aim at a correct understanding of what is happening in matter in its innumerable aspects and the reality underlying these changes. The biologist seeks to elucidate the phenomena connected with the organism, but his study is never thorough unless an attempt is made to correlate the relation of the changing organism to the external world. It is not possible to explain correctly the form, shape or function of a particular organ, or the behaviour of a particular organism and its relationships to other organisms, without taking into account the third consideration mentioned above, in other words, that every organism is trying to fit itself to live in its particular surroundings. This effort on the part of the organism is, to a large extent, conditioning its structure, its behaviour and its life-processes.

The primary object of taxonomy, or the systematic study of a group of animals, is to discover their relationships and to facilitate the advancement of this object by assigning to groups of individual kinds of organisms generic and specific names, grouped into more comprehensive sections such as families, orders, etc., according to the method instituted by Linnæus. Such names when first proposed must be accompanied by a description of the animal to which it applies, in which, so far as is possible, its relationships must be emphasised. It is assumed that the manifestation of relationship is resemblance, and in order to establish the affinities of one species with another they must be generally similar in structure, development, behaviour and habits. Practically, however, complete information about an organism is very often not available, and the systematist has therefore to make the best of the data at his disposal (which at present is for the most part morphological) in expressing an opinion on the affinities of the organisms he has studied. In doing so, he assumes further that the individuals showing these resemblances will breed true, and that no two such groups regarded as different will interbreed in Nature in ordinary circumstances. To this conception of closely allied, but different, groups of individuals the name "species" is given. In considering this concept of a species, it must be remembered that a general statement or "law" is true only within certain limits, and that the same organism will behave differently when these limits are exceeded and will acquire new properties and characteristics.

Resemblance presupposes differentiation. The recognition of resemblance follows from the true estimation of the value of differences in characters, and for the purpose of establishing relationships the proper estimation of this value is very important. The value of characters varies according to the group of animals dealt with, what is considered sufficient for establishing a species in one group being considered insufficient in another. The appreciation of this depends on the systematist's experience and on the extent to which data are available. In some groups (*e.g.* trypanosomes) where anatomical data afford no clue for the differentiation of species, the physiological reactions they produce are relied on for specific determination. The variation of the value of characters is a fact that the taxonomist must always bear in mind.

Zoology has from its beginning been an observational science, and even now its purely observational and descriptive aspects have by no means been exhausted. Important conclusions have been derived from observation alone. It is possible to generalise from the observation of a large number of apparent facts, but such generalisations cannot be more than tentative hypotheses, their probable accuracy being proportional to the number of observed facts. It is here that the value of experiment in increasing the proportional accuracy of a hypothesis must be recognised. The observation of an orderly sequence of events in Nature may be considered by some sufficient for a generalisation, but it seems to me that the introduction of a disturbing element in a given series of events must result in giving us a more complete insight into the nature of things. To recognise relationship by the interpretation of structure, physiological reactions and habits of animals, taxonomy would be in a better position if the opinions of the museum zoologist were tested by experiments in development, in breeding, in ecology, and in the habits of the organism. The need for experiment cannot be too strongly emphasised.

Yesterday our astronomy was geocentric; to-day our biology is anthropocentric. Animated Nature has been, and is still, studied and interpreted through human emotions and prejudices, and it is this inability to assume a detached state of mind in studying Nature that is responsible for the lack (as compared with the mathematical sciences) of rigid thinking in biology. It must, however, be admitted that it is easier to maintain an impartial attitude when considering inanimate Nature than is possible in the study of organisms more or less similar to ourselves. We are too apt to regard man as the highest "created" being, superior to all animals, and this view colours most of our observations, especially those of the purely field-naturalist. We have no evidence for supposing that the fair face of Nature exists for the sole pleasure and benefit of man, and until we cultivate the attitude of regarding ourselves as but one kind of organism in the phenomena of life, we cannot hope for careful observations free from personal likes and dislikes. I stress the fallacy of egoism in zoology largely because the systematist has often to depend on the observations of the field-naturalist in his study of the relationships of the animals with which he deals. It is not given to every systematist to be an ecologist or an experimentalist as well, and it is only by the co-operation of untrammelled minds that we can hope for much future progress in biology.

S. MAULIK.

Spermatogenesis in Spiders and the Chromosome Hypothesis of Heredity.

REFERRING to several letters which have appeared in NATURE (September 12, October 3, October 17) on the spermatogenesis of spiders, I have now examined the testes of a number of South African spiders, and it is found that the chromatin behaviour and the absolute dimensions of the spermatogonia and spermatocytes may differ extraordinarily in different species, even when these species are not far removed systematically from one another.

In some of the species there is a variable amount of more or less typical spermatogenesis with the formation of spermatocytes by mitosis, but in addition, in all the species investigated by me, there is an extensive production of apparently functional spermatozoa by some form of amitosis, and in certain species typical spermatogenesis appears to be almost entirely absent.

In the case of *Amaurobius sp*, recently examined by Miss S. D. King, it may very well be that in that species there is a considerable amount of mitosis in the formation of the spermatocytes, but I accept with much less confidence the assumption that the spermatogonia divide only by mitosis. In the thousands of sections of testes which I have examined I have met with very few examples of the karyokinetic division of spermatogonia.

The conclusions which the present observations seem to suggest are:

(1) In spiders it is usual for the spermatogonia to multiply by amitosis.

(2) The spermatocytes arise in a variety of ways, and in certain species the typical mitotic process has been almost entirely superseded by some form of abbreviated or simplified spermatogenesis, and a single spermatogonium may give rise to less than 4 or considerably more than 4 spermatozoa.

In species in which typical sperm-formation is greatly reduced, or practically absent altogether, there may, nevertheless, occur among the spermatocytes a certain amount of incompleted or erratic karyokinesis, but this is sporadic and is not an essential part of the process of sperm-production in those particular spiders. For example, a symmetrical spindle may be formed, but then perhaps no dyaster arises, and afterwards the chromosomes break down and the cell forms spermatozoa in some atypical manner.

(3) In the testes of some species, spermatozoa of two sizes can be distinguished. These may originate in very distinct ways, and the two kinds may be approximately equal in number. There is no evidence that the smaller spermatozoa are degenerate forms. In certain species there seems to be a certain rhythm in the development of the two kinds.

(4) Owing to the fact that in some species the spermatozoa arise almost exclusively by an atypical method, it is not possible to suppose that such spermatozoa are degenerate and incapable of fertilising the ovum.

(5) The spermatozoa may undergo great reduction in size and modification in shape in the epididymis or convoluted tube which connects the testis with the vesicula seminalis. In one species of Attus (?), for example, the spermatozoa in the epididymis become converted into short, stout and perfectly straight rods, and in another species of the same or allied genus they assume a very characteristic and symmetrical fusiform shape. The distinction between large and small kinds of spermatozoa, which may be well-marked in the testis itself, becomes less obvious in the mass of ripe spermatozoa contained in the epididymis and vesicula seminalis.

It is thus clear that there is a remarkable and very interesting diversity in the character of the ripe spermatozoa of spiders.

(6) The multiplication of the spermatogonia by amitosis and the great differences which occur in the behaviour of the chromatin in the origin of the spermatocytes of spiders renders it exceedingly difficult, or impossible, to understand how the complicated factorial architecture, postulated by the chromosome hypothesis of heredity, could be transmitted in any material sense from one generation to another.

In this connexion it may be stated that in a paper about to be published in the *Annals of the Natal Museum*, I am describing the extensive occurrence of amitosis in the early development of the body-tissues and ovary of the embryo of *Palystes natalius*. This amitosis takes place both by binary fission and by fragmentation of the nucleus, and as these cells form a constituent part of actively growing tissues, it is extremely improbable that their offspring should be incapable of dividing by typical karyokinesis.

With such facts as these before us, it is indeed problematical how any definite arrangement of material genes could be maintained in the chromosomes, either in the growth of the tissues or in hereditary transmission.

As a good corrective to the view of the all-sufficiency of chromosomes, and to the tendency to substitute cellular structure in the place of the directive vital activity of the organism, I would recommend a close study of spider spermatogenesis.

ERNEST WARREN.

Natal Museum, Pietermaritzburg,
December 8.

Measurement of Radiation Intensities by Photographic Methods.

THE use of the photographic plate for the comparison of radiation intensities is becoming of greater importance every year. There are two essentially different methods available, and since considerable work is being done in connexion with the method which appears to us least sound, it does not seem out of place to record briefly the general principles involved, with the view of indicating which, in the opinion of the staff of the British Photographic Research Association, is to be preferred.

The first method, and one which has been used very considerably in the past, depends on the characteristics of the particular kind of plate used in making the measurements, that is, it involves the preliminary calibration of the plate. By this is meant a determination of the blackening or photographic density which results from various exposures to known intensities of the same quality of radiation as is to be measured, that is, an accurate "characteristic curve" of the emulsion must be determined. From such a curve the intensity corresponding to any given density is read off. If the actual times of exposure employed when measurements are being made are not the same as those used when the particular kind of plate was calibrated originally, then the problem becomes very complicated owing to the failure of the Bunsen-Roscoe law, which states that a given density is produced by a given value of the product of intensity and time, and is independent of the actual values of each factor. To get over this difficulty the preliminary calibration has also to include a determination of the value of the so-called Schwarzschild's Constant, that is, the value of p in the expression $D=I\,.\,t^p$, connecting the density with the intensity and time of exposure. Still further complications arise, since p is not usually a constant, but varies with the intensity. When in addition one realises that these characteristics must be determined for every different wave-length which it is desired to measure, some idea is obtained of the immense amount of preliminary work involved. Further, it is possible for a new batch of plates, presumably of the same kind, to be sufficiently different to upset the results completely.

The main feature of the second method is that the plate is used solely as a detector of equal intensities of the same kind of radiation, that is, the only assumption made is that on adjacent portions of a plate, radiation of the *same* intensity, of the *same* quality, acting for the *same* time, will produce the *same* effect when the plate is developed. To compare the intensities of two beams of the same wave-length by methods based on this principle, the intensity of the stronger beam is cut down until the effect it produces on the plate is the same as that of the weaker for the same time of exposure, etc. For example, if this is achieved when the stronger beam has to be cut down to one-tenth (by a method which does not involve an intermittency effect), then it follows at once that the ratio of the original intensity of the stronger to that of the weaker is 10 : 1. Obviously the great advantage of this method is that it is independent of the kind of plate used, so that all the arduous work of calibration is avoided, and one depends for accuracy, so far as the photographic plate is concerned, only on the constancy of emulsion characteristics over a small portion of any single plate, a fact which must make for considerably greater accuracy. This method, of course, involves the cutting down of the intensity of the stronger beam in a known manner at all wavelengths, preferably by a "neutral" absorbing screen. No difficulty now seems to exist in regard to this, since successful methods have been used by various workers.

As has been stated, this note is prompted by the amount of work which is still being done on the calibration of certain types of commercial plates, presumably with the view of using them for the first method described above. In our opinion the second method is vastly to be preferred.

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Valence Theories and the Magnetic Properties of Complex Salts.

I HAVE followed with considerable interest the discussion which has been recently carried on in NATURE by Messrs. Jackson, Welo and Baudisch on the magnetic properties of the complex compounds of iron and other elements belonging to the first transition group. Two papers on this subject have recently been contributed by me, the first of which was sent in June to the *Philosophical Magazine* and deals with those complex compounds, the magnetic properties of which have been studied by Rosenbohm and Oxley. I have defined with Sidgwick the "effective atomic number Z'" of the co-ordinating atom in any complex compound, as the sum total of all the electrons contained in the former plus the number of electronic orbits which this atom shares with the neighbouring atoms and groups in the co-ordination compound. It can be shown that $Z' = N - E + 2P$, where N = atomic number of the co-ordinating atom, E = its primary valency in the given compound and $P = 4$, 6, etc., according as the complex compound is either fourfold, sixfold, etc.; *e.g.* in the ferrous compound $K_4[Fe(CN)_6] + 3H_2O$, $Z' = 26 - 2 + 2 \times 6 = 36$; while in the case of the fourfold compound of copper $[Cu(NH_3)_4](NO_3)_2$, $Z' = 29 - 2 + 2 \times 4 = 35$. These numbers can be independently calculated by the rule which has been given by Sidgwick.

In the above-mentioned paper I have shown that if Z represents the atomic number of the inert gas which terminates any transition group of elements, *e.g.* in the case of the iron group the inert gas is krypton with $Z = 36$, then all those co-ordination compounds, in which $Z' = Z$, are diamagnetic, while the others are paramagnetic. This result agrees with that given by Messrs. Baudisch and Welo in their letter (NATURE, October 24, p. 606). In a second paper, which was written immediately after the publication of Mr. Welo's letter in NATURE (September 5, p. 359) and has been sent to the *Zeitsch. f. Physik* for publication, I have shown that the number of Bohr's magnetons contained in any co-ordination compound of the first transition group of elements, the magnetic properties of which have so far been studied, is given by $Z - Z'$. The following table shows how the values of the magneton numbers, calculated according to the above rule, agree with the experimentally determined ones:

Compound.	Exp. Magneton No.		Eff. At. No.		
	Weiss's	Bohr's	Z'.	Z.	$Z-Z'$.
$[Cr(NH_3)_6]I_3$	19	3 (19·2)	33	36	3
$[Fe(CN)_6]K_4 + 3H_2O$	Dia	Dia	36	36	0
$[Fe(CN)_6]K_3$	10	1 (8·6)	35	36	1
$[Co(NH_3)_6]Cl_3$	Dia	Dia	36	36	0
$[Ni(NH_3)_4]SO_4$	13	2 (14·1)	34	36	2
$[Ni(NH_3)_6]SO_4$	16	2·5 (16·7)	38	36	2
$[Cu(NH_3)_4](NO_3)_2$	9	1 (8·6)	35	36	1

I have placed in brackets next to the Bohr's magneton numbers, the equivalent number of Weiss's magnetons, calculated on the assumption that the co-ordinating atom is in the "S" state. It will be seen that there is good agreement between the calculated and experimentally determined number of Bohr's magnetons contained in this class of co-ordination compounds. It remains to be seen whether further investigations will show that modifications are necessary. Incidentally, the above rule affords further evidence of the reality of Bohr's magnetons.

D. M. BOSE.

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November 19.

Mendelian Genes and Rates of Development.

PROF. J. S. HUXLEY and Mr. E. B. Ford have directed attention in NATURE of December 12 to the developmental mechanism connecting the Mendelian gene and the visible character. A field for an attempt to learn something about this mechanism was suggested to me some little time ago, by Prof. W. Garstang. Many problems of genetics, he pointed out, are connected with the hair and its colour in mammals, and therefore any process that is concerned in the distribution, development, or succession of hairs should be studied as minutely as possible.

My work has so far been confined to the mouse (*Mus musculus*). A study of the coat was first carried out as a piece of pure morphology in order to provide the necessary basis for the examination of the effects of known genes. A paper on this is shortly to appear. It will be enough to mention the following points. The hairs of the same region of the coat are of several types; the growth of a hair takes place entirely at the basal end, any individual hair taking about four weeks at the most to become fully formed; and, broadly speaking, all the hairs growing at the same time in any small area of the skin pass through much the same stage of development together.

At present I am occupied with the colour pattern of the wild mouse. Agouti, as is well known, is a simple dominant to black. Agouti differs from black in that some hairs have a sub-apical pale band that is in most cases yellow, though some are black throughout. As Prof. Garstang himself anticipated, there has proved to be a simple key to the agouti pattern. On the back of the mouse the presence or absence of the light band can be correlated with hair-type; and in types possessing the band its length and shade can be correlated with the size of the whole hair or of some part of the hair. In every case there is some dark pigment at the apical end, the part of the hair first formed. Within a short distance in yellow-banded hairs the dark pigment gives place partly or completely to yellow, and then proximally black gradually replaces yellow, and no yellow pigment is formed in the rest of the hair. In some cases no yellow pigment can be seen in the light band, but the concentration of the dark pigment is less than in the adjacent regions. In attempting to interpret the facts just outlined, various details of hair development must eventually be taken into consideration. It may be mentioned that in the follicles of two adjacent hairs of the same type, in one the yellow band may be in process of formation after the banded portion of its neighbour has been fully formed and the production of black pigment resumed.

In the light of the discussion of the agouti pattern in rodents by Sewall Wright (*Carnegie Inst., Wash.*, 241, 1916, and *Jour. Heredity*, 8, 1917), and of Onslow's work cited by Huxley and Ford, we may conclude that in the region of the light band the production of black pigment is partly or completely inhibited, while, of course, the colour of any part of a hair depends upon the rate at which different substances are produced.

Some few months ago I was able to discuss this work with Prof. Huxley, who suggested subjecting the animals to different conditions and observing the effect upon the agouti pattern. It also occurs to one that comparative studies should be made on the series of multiple allelomorphs, yellow, white-bellied agouti, agouti, and black. It has not yet been possible to undertake these investigations. They are mentioned as indicating further the possible usefulness of this line of inquiry.

F. W. DRY.

The University, Leeds, December 15.

The Leaping Salmon.

THE word salmon, in late Latin *Salmo* (for the fish was unknown to the Greeks), comes from *salio*, to leap; for all salmon run up the streams from the sea in the fall to cast their eggs in clear cold waters, for them to hatch as the waters grow cold. In this regard they are unlike most other fishes (birds and reptiles as well) whose eggs hatch as the weather becomes milder.

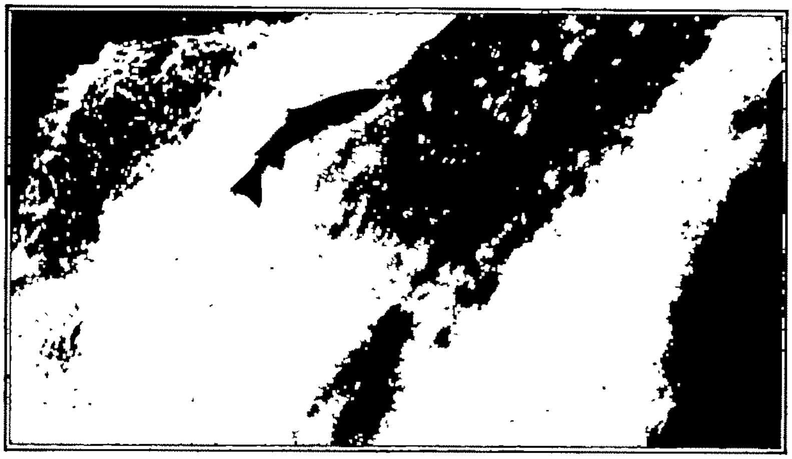

FIG. 1.—King salmon leaping the Punch Bowl Falls, Cascade Range, Oregon, 30 ft. high.

When salmon encounter a waterfall, they leap over it if they can. In a broken cascade they may worm their way through and around. This is true in tributaries of the Atlantic and Pacific alike. But while there is but one kind of salmon in the Atlantic, and that one much like a big trout, there are five kinds on our Pacific coast, and those quite different from the Atlantic salmon as well as from one another. These are the king salmon, known also as Chinook or Quinnat; the red salmon of Alaska, known as Blueback and as Sockeye (*Sukkegh*); the silver salmon or Coho; the calico salmon or Chum; and the hunchback salmon. All these agree in developing but one set of eggs, dying after once spawning. The noble salmon, king and red, mostly spawn the fourth year; the smaller hunchback the second year, the others at three or four. A few individuals delay the operation, growing to a correspondingly larger size. The red salmon, unlike all others of its kind, enters only streams that have a lake in their course. They spawn in streams at the head of the lake, and in it the young fishes mostly spend their first year. The other species are less particular, but some of them will ascend a stream for fifteen hundred miles (to Lake Laberge in the Yukon country, for example) before the suitable stream is found.

All salmon will leap over a waterfall where it is possible or necessary. I present here the finest picture of a leaping salmon I have ever seen (Fig. 1). An artist has to be keenly on the watch to take a picture like this. It represents a king salmon of about twenty-five pounds springing over the Punch Bowl Falls in the Cascade Range, Oregon, the height being about thirty feet. For this picture I am indebted to a former student, Helen Gibson (now Mrs. Rockhold), resident in Oakland, and for the purpose of placing this charming picture on record, I write this little sketch.

DAVID STARR JORDAN.

Detonating Meteors.

THE descriptions of a brilliant meteoric fireball in NATURE of November 28, p. 795, and in two letters dated November 17 and November 28 from Mr. W. F. Denning to the *Times*, give details of the attendant acoustical phenomena which are perhaps worth examination.

It appears that at least 25 miles above Hounslow detonations occurred, and these not only originated sound at that great height, but were also heard loudly at Caterham after passing down through at least 30 miles of the atmosphere.

The loud and thunder-like sounds would appear to be the chief, if not the only, reason for supposing a detonation to take place. Mr. Denning has confirmed in a letter to me that the accepted explanation of the origin of the sound is that there is a detonation resulting from the great heat due to the swift passage of the meteor against the resistance of the air.

The sounds need not necessarily arise from a detonation or explosion, however, for a body moving through the air with a velocity greater than that of sound will on that account give rise to an intense and sudden sound, which in the now familiar case of a high velocity shell or bullet was commonly supposed to originate from the explosion of the propellent charge. The "shell wave" or "onde de choc" to which the loud crack is due is readily understood if Huyghen's principle is applied to this case, supposing the body to be causing disturbances in the air all along its path in the same way as a slowly moving object causes a rushing or tearing sound. Prof. Boys has actually photographed the "onde de choc" of a bullet in flight (reproduced in Barton's "Text-Book on Sound," p. 82), but we have a familiar analogy in two dimensions in the bow wave of a ship.

It is difficult to estimate the speed of sound at a height of 25 miles, but the result of an experiment by S. R. Cook (*Phys. Rev.*, 23, pp. 212-237, September 1906), on the speed of sound in air at liquid air temperatures, might be taken as a limiting case. At 91° A. he found the speed to be 181 metres per second. The speed computed for the fireball of November 15 was about 17 miles per second. At 91° A. this would be about 150 times the speed of sound, and at normal ground temperatures of, say, 283° A. it would be still 80 times the speed of sound. For these high speeds the "onde de choc" would be a conical wave of such a narrow angle that the wave front could be regarded as parallel to the line of flight. This fact might serve to discriminate between sounds due to an explosion at a point in the path of the meteor and that due to its "onde de choc."

In the case of thunder to which the sound of the meteor has been likened, the originating lightning flash is practically instantaneous and usually takes a very irregular path. The sound wave begins with a front shaped like the flash, and this, even more than reflection, probably accounts for the prolonged sound of rising and falling intensity to a distant observer. The flight of a meteor is more regular, and its sound would be expected to be more uniform in intensity than thunder. It may, however, be complicated by the separate "ondes de choc" of fragments thrown off in the course of its flight.

P. ROTHWELL.

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December 18.

Einstein Shift and Doppler Shift.

IN answer to Sir Oliver Lodge's question (NATURE, December 26, p. 938), it depends on our point of view whether the Einstein shift is considered to be imposed on the light at its origin or in course of transit to us. We cannot state the frequency of the ether vibrations without presupposing a system of time-reckoning, and in the non-Euclidean region round the gravitating star the ordinary conventions of time-reckoning have broken down. There is a particular system of time-reckoning (t) commonly used in relativity investigations; but it must be understood that no merit is claimed for this system except that it renders certain calculations easier. In this reckoning the Einstein shift occurs at the origin of the light, and is carried to us by the light without change. But if we pay attention rather to the proper-time (s), which gives us an absolute point of view, atomic vibrations have the same period s wherever they are situated; and the Einstein shift is imprinted on the light as it travels through the non-Euclidean region into the comparatively flat region of space-time where we observe it.

The answer to any problem of observation must, of course, be the same whichever point of view we take. The companion of Sirius will not produce the shift in light reflected by it from another source, because alternatively (1) no change of period t occurs, or (2) the change of period s during the approach is neutralised during the recession. I should add, however, that the so-called reflection of the light of one star by another (often conspicuous in eclipsing variables) is really an absorption followed by re-emission; and this kind of "reflected" light would suffer the Einstein shift.

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Genes and Linkage Groups in Genetics.

IN the flatfishes "mutations" are not uncommon; albinos, piebalds, etc., reversed examples (sinistral individuals of dextral species and dextral individuals of sinistral species), and ambicolorate fish. There are many degrees of ambicoloration, from specimens with a small coloured patch or a few scattered spots on the blind side to others in which the whole blind side is coloured like the eyed side. When ambicoloration is complete, or nearly so, it appears always to be associated with other variations; the migration of the eye is delayed, so that it gets in the way of the dorsal fin as it is growing forward on the head, the scales of the blind side resemble those of the eyed side in structure, the asymmetry of the paired fins is less marked. It is clear that the one thing that holds these variations together is that they are variations towards symmetry, and it is interesting to note that the head, which is the most asymmetrical part of the fish, is the last to be affected; thus it often happens that the whole blind side is coloured except a patch in the orbital region, and that the scales of the blind side are as rough as those of the eyed side except on the head.

The basis of this linkage group—ambicoloration, monomorphic scales, delayed migration of eye—is a tendency towards symmetry. These facts seem to be capable of an interpretation not very different from that given by Prof. MacBride in his letter in NATURE of December 26, p. 938.

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The Palæolithic Drawing of a Horse from Sherborne, Dorset.

IN the third edition of his "Ancient Hunters," p. 536, Prof. W. J. Sollas states that the drawing of a head of a horse on bone from Sherborne, which I described in 1914 as an example of Palæolithic art, "is a forgery perpetrated by some schoolboys." I read this statement with surprise, because the bone is in a semi-fossilised condition, and I think all who study the specimen will agree that the drawing must have been made when it was fresh. When it was exhibited to the Geological Society, indeed, it was generally accepted as of Palæolithic age. Through the kindness of Mr. Nowell Smith, headmaster, and Mr. R. Elliot Steel, formerly science master of Sherborne School, I have therefore communicated with Mr. Arnaldo Cortesi, the survivor of the two schoolboys who discovered the bone. He writes, "I confirm the genuineness of the find," and remarks that at the age of fifteen years he was too ignorant of the subject to take part in any such "trick" as Prof. Sollas suggests.

I may add that in the autumn of 1923, with the kind permission of Major Wingfield Digby, Mr. Elliot Steel and I examined one of the fissures in the quarry whence the bone is supposed to have been obtained, but we had no success. The teeth of mammoth and rhinoceros from the lower part of the same valley, now in the Sherborne School Museum, are still the only other Pleistocene remains from the neighbourhood.

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Aptitude and Achievement.[1]

By Prof. J. McKEEN CATTELL.

THERE was published in 1890 in *Mind* an article entitled "Mental Tests and Measurements," and in 1896 in the *Psychological Review*, established in the meanwhile in co-operation with Prof. Baldwin, an article entitled "Physical and Mental Measurements of the Students of Columbia University." This was the first series of tests used with a large number of individuals, and it still remains the most extensive undertaking of this character. The students were tested at the beginning of the freshman and the end of the senior year, the women of Barnard College as well as the men of Columbia College.

About an hour was given to the examination of each student, and some thirty measurements were made, ranging from height, weight, and lung capacity, through keenness of sight, discrimination of pitch and reaction time, to memory, imagery, and association. In addition, some forty records and observations were made, ranging from colour of eyes and hair to an estimation of intelligence and straightforwardness. Further, the student at home filled in a blank answering some eighty questions, ranging from the ages and, if deceased, cause of death of his grandparents, to what profession or business he proposed to follow and in what calling he would prefer to succeed if he had his choice. Other information was also available, including class standing in different subjects, success in athletics, and social interests. It is possible to follow the careers of alumni in after life and to measure their children when they in turn come to college at about the same age. In addition to the Columbia students, these tests were made on members of the American Association for the Advancement of Science at three annual meetings, measurements having been obtained of men so distinguished as Simon Newcomb and William James. At the St. Louis Exposition of 1904 a laboratory was set up and tests were made by Prof. Woodworth and Dr. Bruner, both on the visitors and on the racial groups that were represented.

In working over the tests, Dr. Wissler used for the first time in psychology the methods of correlation developed by Francis Galton and Prof. Pearson. The correlations among the grades in different studies were significant and have been the basis of many subsequent studies. The lack of correlations among the measurements was at the time disappointing. It is due in part to the attenuation from measurements that are only accurate when deduced from averages, in part to a real lack of correlation in different traits. For example, a student who is accurate may be as likely to be quick or slow as one who is inaccurate. There is no correlation, but one-fourth of all students will be above the median, one in a hundred in the first tenth, in both accuracy and quickness, and will have a great advantage. The correlations—due to the circumstance that the same abilities and training are involved—discovered among complicated performances, such as class work and intelligence tests, have led to their cultivation and to the neglect of the simpler measurements. The cultivation is desirable, the neglect unfortunate. It is of interest to any one to know where he stands among others in these traits and determinations; some of them, such as colour-blindness or acuity of hearing, which can be measured in a couple of minutes, may be of real use. It is also the scientific method to be followed in analysing the more complicated processes, such as those going under a term so ambiguous as general intelligence.

Estimates of character and of other psychological traits are difficult and untrustworthy. No correlation has been found in the Columbia laboratory between size or shape of head and ability of any sort. There is no known relation between complexion, forehead, nose, chin, or other features and psychological traits. The reading of character by physiognomy or graphology is the occupation of charlatans. It is difficult or impossible to tell even the sex of the individual from the features of the face or from the handwriting. These are, of course, legitimate subjects of study. The full and side face have been photographed through a centimetre netting with a long focus lens, thus obtaining in a moment a large number of determinations, which are on the average as exact as can be got by direct measurement. The method can be used to advantage with children or savages, who do not like to be measured, and it is useful in recording and preserving a large number of determinations, some of which may prove to be of unexpected value. Photographs of the face were cut in parts to determine by what features we recognise the individual, and estimate the age, sex, etc. A study was also made in which individuals were judged first from a photograph, later after a five-minute interview, and then by individuals who knew them well.

It is possible to put judgments of character on a quantitative basis. In the earliest undertaking of this character, five instructors in Columbia University were graded on a percentile scale by twelve fellow-instructors and graduate students. Twenty-four traits or qualities were included, ranging from physical health to efficiency and leadership. There were used the psychological categories of intellect, emotion, and will, together with the quantitative differences to which they have a certain analogy, breadth, intensity and quickness. All these qualities are useful, but it is especially desirable that a scientific man should have broad intellect, an artist intense emotions, a soldier or statesman quick will. We can fancy that these are unit characters which are combined by chance in Mendelian fashion. The probable error in position in a centile order for different traits estimated by twelve observers was only 4 places, ranging from 3 to 5·2, and apart from constant errors there is thus a close agreement. The chances, for example, are even that a man ranked 51 for integrity, with a probable error of 5, is more honest and straightforward than 45 of a hundred of all scientific men and less so than 44. A man ranked 95 for courage with a probable error of 3 is to the best of our knowledge more courageous than 9400 of the 10,000 scientific men of the country, and the chances are even that this position is correct within 300 places. There was greater agreement on mental balance than on physical health; there was least agreement on cheerfulness, most on energy, perseverance, and efficiency.

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[1] From the address, entitled "Some Psychological Experiments," of the retiring president of the American Association for the Advancement of Science, delivered at the Kansas City meeting on December 28, 1925.

There is a certain amount of validity in judgments of personal traits, character, and performance, and individual differences in the reliability of the judgments of those taking part in these experiments have been measured, showing a variation in competent observers covering a range of about two to one. It is an accepted truism that success in business and in other directions depends on the wise selection of associates and agents and on the ability to predict how others will act in given circumstances. When we learn to look upon our observations, recollections, beliefs, and judgments objectively, stating in numbers the probability of their correctness, there will be an extraordinary change in our attitude in religion, politics, business, and all the affairs of life.

Before the selection of a thousand students of Columbia University and a thousand American scientific men, a study was made of the thousand most eminent men of history, and this was the basis for the later studies by order of merit. From each of six French, German, English, and American biographical dictionaries or encyclopædias were selected about 2000 of those allowed the longer articles. From the some 6000 individuals so determined were taken those who appeared in at least three dictionaries, and from these were selected those given the greatest average space, the several dictionaries being reduced to a common standard. Thus was obtained not only the thousand men given most attention, but also the order in which they stand. The method further permitted the assignment of a probable error of position, which can be used as a measure of differences in eminence, and, if we assume the distribution of the probability curve, the differences between eminent men and average individuals.

Curves may be drawn showing the historical distribution of eminent men by nationality and by performance. After the Greco-Roman period and the so-called Dark Ages, there is a rise in numbers from the tenth century onwards, but with definite fluctuations in productivity. In the fifteenth century, Italy, England, France, and Germany had nearly the same number of eminent men. Italy was in the lead, but then falls, as does Germany, while England and France rise, their curves crossing through the centuries with nearly an equal number of distinguished men, England surpassing in the number of highest eminence. France reaches its culmination at the end of the eighteenth century. Germany rises rapidly from the second half of the seventeenth century, and the American curve then begins with much promise for the future.

An analysis of the kind of performance shows that France has excelled in war, science, and scholarship, England in politics, poetry, and philosophy, Italy in art. Of the eighteen great musicians, Germany has produced ten, Italy six. Of the fourteen great explorers, England has produced five, Spain four. Though text-books and treatises on history, at least until the most recent period, are mainly concerned with wars and politics, there have been fewer eminent sovereigns, soldiers, and statesmen than scientific men, philosophers, poets, artists, and the like. The rising curves for science, the falling curves for philosophy and the church, are significant. Soldiers have been surpassed in numbers by men of science, and the curves predict a gradual cessation of war and the predominance of science. Similar curves have been made for the percentage of the total population of different countries engaged in war through the centuries, and though the data were inadequate, they also point to the gradual elimination of war. But, of course, the projection of curves is a scientific method that must be used with the utmost caution. By similar methods a list of 1000 American scientific men who died prior to 1900 has been compiled, and the changing interests can be shown by curves. A quantitative study of history is a possibility of the future.

Data have been collected concerning some of the 1000 eminent men of history and a supplementary list of 10,000 has been used, with the view of placing information in regard to them on a statistical and quantitative basis, determining how they differ among themselves and from others, and the conditions favourable to performance. Our present information is from anecdotes and examples from which almost anything can be deduced. We do not even know whether history depends on its great men or whether these are by-products of economic and other forces. We do not know the extent to which their performance depends on heredity and on opportunity.

The distinctions hold not only for men of eminence, but also extend to differences adapting ordinary individuals to the work that they can do best. Thus three types of people, intergrading but often well defined, are those most satisfied and competent when dealing, respectively, with personal and emotional relations, whether the poet or the salesman; with material objects and definite situations, whether the military leader or the mechanic; and with abstractions, whether with the Deity or the atom, or simply with words and figures. In the transportation services, most of the employees have functions separated on the lines of these three types. The clerks, bookkeepers, and stenographers are concerned with words and figures; the conductors and pursers must remember faces, be obliging, ready to answer questions, interested in the affairs of the passengers; these traits are disqualifications for motormen and engineers, who should be concerned about objects and machines. By a rough natural selection those tend to become clerks, conductors, or engineers who are best suited for the work, but probably more than ten per cent. of the employees could be transferred with an average increase of more than ten per cent. in their efficiency; new employees could from the start be assigned to work for which they are best fitted. By the use of the psychological tests that we now have and by research to perfect these tests, the corporations concerned with transportation could effect a direct saving measured by tens of millions of dollars a year, indirectly of a comparable sum through the greater welfare and contentment of their employees.

In addition to the groups already noted, a study has been made of American men of science, selected by the order of merit method. The sciences were divided into twelve groups and the number in each was taken approximately proportional to the total number of scientific workers, ranging from 175 chemists to 20 anthropologists. In each science the men were arranged in the order of the value of their work by ten leaders. The average positions and probable errors were then calculated, giving the order in each science. These were interpolated to give a list of about 2000 names, but in the main only the first thousand have been considered. The list was obtained in 1903 and again in 1910. In 1920 it was compiled for the third time, but by a different method, used partly for its scientific interest, partly in order to avoid too great demands on the time of a few leading scientific men and to prevent any inbreeding from a limited number of judges.

The names and addresses of the scientific men included in each science in the two previous selections were sent to those on the list and they were asked to increase it by about 20 per cent. All those who received more than one vote were then asked to make nominations, and those who received the most votes were added to the list up to a number of names twice as large as was to be selected. The names were then sent in alphabetical order to each of those included, and he was asked to check about half the names to indicate those whose work he regarded as of most merit, with a double check for about one in twenty whose work he considered the most important. Some 2000 scientific men were asked to take part in the selection, and about 1000 complied. The probable error of the position of the individuals was nearly the same as before. The measurement of the validity of a vote has application from the decision of a committee to a national election.

The scientific men are thus arranged in the order of the value of their work with a probable error which shows the correctness of the position assigned to each and also measures the differences between them. It consequently becomes possible to measure the scientific productivity of a region of the country or of an institution and its contemporary strength, with the changes that occur at different periods. The single figure giving the gain or loss in position of a scientific man in the course of ten years condenses a great deal of information and is dramatic in its implications. When we put knowledge concerning men of science on a statistical and quantitative basis, we may hope ultimately to determine the hereditary and environmental conditions favourable to the production and to the productivity of workers in science.

There are large variations in the origin and in the present residence of scientific men throughout the United States. Their birth rate per million of population was 109 in Massachusetts, and decreased from that centre to 47 in New York, 23 in Pennsylvania, 9 in Virginia, less than 2 in the Gulf states. Their present residence tends to correspondence with their place of birth, but some cities and states obtain more scientific men than they produce, and conversely. Scientific activity is moving westward. Of younger men added to the list, the birth rate fell in Massachusetts from 109 to 85, in New York from 47 to 36, whereas it increased in Michigan from 36 to 74, in Minnesota from 23 to 59.

In academic production and possession of scientific men, Harvard leads by a wide margin, though the Johns Hopkins has given nearly twice as many doctorates to those who have attained scientific standing. In 1920 there were at Harvard 73 of our thousand leading scientific men. The numbers in other large institutions were—Columbia, 42; Chicago, 39; Yale, 35; Johns Hopkins, 35; Cornell, 33; California, 31. From 1905 to 1920 the net gain was at Yale, 9; at Harvard, 7; at the Johns Hopkins, 5; at California, 4. Chicago and Cornell were stationary; the net loss at Columbia was 18. The men can be weighted, in which case the relative strength of Harvard becomes greater. The ten strongest departments in each of the twelve sciences have been determined, Harvard among universities standing first in mathematics, physics, chemistry, botany, zoology, pathology, and anthropology; second in geology and physiology. The Johns Hopkins had one of our leading thousand scientific men for 37 students. At Harvard the ratio was 1 : 75, at Yale, 1 : 105; at Columbia, 1 : 202. In the fifteen-year period the Department of Agriculture had a net loss of 9, the Geological Survey of 6, the Smithsonian Institution of 5; the Bureau of Standards a gain, of 11. The Carnegie Institution and the Rockefeller Institute had large gains, as had also the industrial laboratories. The movement of scientific men to the research foundations and laboratories is one of the notable changes of the past twenty-five years.

The list of a thousand scientific men permits not only the measurement of scientific merit and a study of the origin and distribution of scientific workers, but also offers opportunity for obtaining vital and other statistics. Thus, to take an example, the average size of the completed family of the scientific men is 2·2. Voluntary control increased from 48 per cent. of marriages prior to 1880 to 70 per cent. of those contracted in the 'nineties. Childlessness was involuntary in two-thirds of the cases; the standardised two-child family was desired in six cases out of seven. Or again, the brother of a scientific man is two hundred times as likely as another to be himself a scientific man.

We need scientific knowledge concerning scientific men and the conditions favourable to scientific work and to the scientific career. In the course of the week during which these remarks are being written, Secretary Hoover in an address to the Society of Mechanical Engineers has stated that the United States is behind most European nations in scientific research, and President Butler in his annual report has stated that Columbia University cannot replace " older scholars of distinction and large achievements," because " a choice must be made from a larger or smaller group of mediocrities." It may be that we are inferior to other nations and that we now produce fewer scientific men of distinction than formerly, but both statements are open to question. The circumstance that they are made by men of wide information and can be neither proved nor disproved shows the urgent need of correct information.

It is the business of psychology to secure such knowledge, to determine how those fit for scientific research can be selected, what training should be given to them, what positions, opportunities, and rewards are most effective. Scientific men should apply scientific methods to their own work and to securing the widest co-operation. Books and journals, including technical publications for scientific men, others that will interest the "average man" in science and in the wider application of the scientific method, are leading agencies. Science Service, for which the American Association shares the responsibility, should be made a large factor in the dissemination of science. But of all agencies for the promotion and diffusion of science, scientific societies are the most important—the national societies in each science, the state and local academies, most of all the association in which these are united and which at its annual meetings and at all times advances the interests of science and of scientific men and impresses on the widest public the weight and magnitude of modern science.

In spite of the limited value for science of direct introspection, our mental life is part of the real world, and is that part which is of the greatest concern to each of us. It may be, as has been suggested, that psychology lost its soul long ago and is now losing its mind; but it cannot lose consciousness. Our perceptions, thoughts, intentions, and feelings are not only elements in sensori-motor arcs; for us they are also the end to which the whole creation moves. So far as production goes, consciousness may be only a spectator; but it is the ultimate consumer. We shall have in due time a scientific psychology of human welfare, of the things that are beautiful, good, and true. But it will not come until we get these things instead of talking about them; for science has meaning and value only in its usefulness. Psychology may supply economic values equal to those of the physical and biological sciences, human values of even greater significance.

Scientific research and the applications of science in the course of 150 years have increased fourfold the productivity of labour; they have doubled the length of life. Science has made it possible for each to work at routine tasks half as long as formerly and at the same time to consume twice as much wealth as formerly. Fourteen hours of labour, shared by women and children, once provided hovels, lice, and black bread for most people, luxury for a few. Seven hours of labour will now supply comfortable homes, warm clothes, and healthful food for all. If the resources provided by science were properly distributed—as they will be when we have an applied science of psychology—there is now sufficient wealth to enable all to share in the desirable luxuries that science has created, and to enjoy in full measure the most nearly ultimate goods of life—home, friends, things to do, freedom, self-respect.

The better lives secured through the increased wealth provided by science, together with the applications of science to hygiene, medicine, and surgery, have doubled the length of life. In the nations of the west, pestilence and famine have lost most of their terrors; of the three evil fates, only war survives from a pre-scientific and barbarous past. Much is crude and ugly in the modern world; atrophied instincts and aborted impulses must be replaced by the products of a science of psychology before living can become free and fine. But those who call our industrial civilisation materialistic and ignoble have narrow thoughts and scant idealism. They fail to imagine what it means in terms of love and suffering that of ten infants born, formerly only two or three survived childhood, while now eight or nine may live to have children of their own.

The applications of science have abolished slavery and serfdom, the need of child labour, the subjection of woman; they have made possible universal education, democracy, and equality of opportunity, and have given us so much of these as we have. Science has not only created our civilisation; it has given to it the finest art and the truest faith. The advancement of science should be the chief concern of a nation that would conserve and increase the welfare of its people.

The Progress of Directional Wireless Communication.

By Dr. R. L. SMITH-ROSE.

FROM the earliest days of practical wireless communication, it was realised that one of the most important services which this art would render to humanity was its contribution towards the safety of life at sea. The possibility of a ship being able to keep in communication with the remainder of the world during the longest voyages, and, in time of distress, to broadcast an appeal for assistance, has removed much of the terror of shipwreck and fire at sea. A later development, which bids fair to rank second in importance to the above, is the direct application of wireless to aerial and marine navigation. There are, broadly, two methods by which a wireless signal may be used to determine the direction of any given fixed point. In the first, the direction of arrival of the signals from any transmitting station is determined by means of a direction-finder. The second method involves the transmission of a rotating beam of large or small angle and its reception on any suitable receiver.

The wireless direction-finder makes use of the fact that in electromagnetic waves travelling over the earth's surface, the magnetic force of the waves is horizontal and perpendicular to the direction of transmission. If a closed loop or coil of one or more turns with its plane vertical is used to receive such waves, the strength of the signal E.M.F. induced in the loop will be proportional to the cosine of the angle between the plane of the loop and the direction of arrival of the waves. Hence, if the loop is rotated about a vertical axis, the strength of the signals received will pass through successive maximum and zero values at intervals of 90°. A consideration of the case shows that the rate of change of the resulting signal strength is greatest when passing through the zero position, which is therefore the most sensitive condition for the determination of the direction of arrival of the waves. In this zero position the plane of the loop is perpendicular to the direction of the incoming waves and thus of the transmitting station.

There are three practical forms of wireless direction-finder in use to-day operating on this fundamental principle of the simple rotating loop: and it can be shown, both theoretically and experimentally, that the accuracy is of the same order for all the systems, each of which has its own field of application. The limiting accuracy to which the modern direction-finder has been developed is about 1°, which, it may be remarked, is ample for the present-day needs of navigation.

Apart from any defects of instrument design and construction, the direction-finder is subject to errors which are conveniently divided into three classes. In the first class are those due to local conditions surrounding the instrument, such as metal-work, overhead wires, and trees. The currents set up in such objects create a secondary field in the neighbourhood which is superimposed on the primary field of the waves, producing a resultant field the direction of which may deviate seriously from that of the original field. It is usual in selecting a site for a wireless direction-finder on land to attempt to avoid such sources of error, but it is seldom that an ideal site can be found. The small residual errors which are experienced are taken into account by calibrating the station on various fixed transmitting stations. Instances in which an error due to the site of the installation is unavoidable are those of ships and aircraft. In these cases the error in apparent direction varies in an approximately sine-wave form with the direction of the incoming waves relative to the fore-and-aft line of the ship. In such installations, either a correction curve is prepared from observations taken while the ship is swung on a fixed transmitting station, or the error is approximately compensated for by a suitable circuit arrangement.

The second class of error is in the nature of a surface refraction effect and is encountered when the path of the waves lies approximately parallel to the boundary between land and sea. If observations are made on wireless waves crossing a coast-line, the direction-finding instrument indicates that the waves in crossing from sea to land experience a deviation in a direction towards the normal to the coast-line at the point of transit. No satisfactory theoretical explanation of this phenomenon has yet been given, but as the error is frequently of the order of 5°, it is customary to avoid, wherever possible, the taking of bearings on waves travelling in a direction approaching that of a coast-line.

The type of error in the third class presents more difficulty in accurate work, on account of its very erratic and variable behaviour. Fortunately this class of variable error is encountered only when the range of transmission exceeds certain minimum values, beyond which the apparent direction of arrival of the waves is subject to somewhat erratic variations, the frequency and magnitude of which are dependent to a limited extent upon the wave-length employed, the distance of transmission, and also upon the season and time of the day at which the observations are made. During the hours of full sunlight in summer, these variable errors have a maximum value of about 4°. As sunset is approached they increase in frequency and magnitude, and from about one hour before sunset until about one hour after sunrise the apparent direction of arrival of the waves varies rapidly on either side of the true direction over an arc which is often 10° or 20° and may occasionally exceed 90°.

The theory which has been developed to explain these errors rests on the same basis as the theory of the fading of wireless signals and of the mode of propagation of wireless waves around the earth's surface. This theory assumes that the upper ionised regions of the atmosphere are operative in deflecting wireless waves arriving from a transmitting station in such a manner that they are eventually returned to the earth's surface. A direction-finding station will thus receive waves from the transmitter not only horizontally along the earth, but also from a downward direction. If, as is possible from several causes, the plane of polarisation of the downcoming waves differs from that normally encountered in transmission along the earth's surface, the direction of the horizontal component of the resultant magnetic field due to the two arriving waves will in general not be at right angles to the direction of transmission. Thus, although there has been no departure of the line of travel of the waves from the vertical plane connecting transmitter and direction-finder, the latter will indicate an error in the apparent direction of arrival. This theory is being supported by the accumulation of a large and varied amount of experimental evidence, and the investigations concerned provide an excellent means of studying the physics of the upper atmosphere.

DIRECTION-FINDERS IN NAVIGATION.

The discovery of the existence of these errors in the course of the development of direction-finding during the War inspired a lack of confidence in this art among those responsible for marine navigation. Systematic research carried out during the last few years has, however, brought to light a state of affairs which has resulted in the reinstatement of the wireless direction-finder as a direct aid to seamen. While the instrument may be used at ranges of several hundred miles to give a general idea of a ship's position, it is in the making of a landfall after an open-sea voyage, or in the navigation of harbour entrances during bad or foggy weather, that the wireless direction-finder is in demand. The ranges at which it is required to operate with accuracy are seldom greater than 50 miles, and never greater than 100 miles. Now the variable errors described above are only experienced when the range of transmission exceeds 30 miles overland, or 80 to 100 miles oversea. Hence, by a suitable choice of shore transmitting stations, the ship's direction-finder can be used to operate on waves travelling entirely over sea, with the result that, within its required range, about 95 per cent. of the observed bearings fall within a 2° limit of error, which is found to be adequate for most navigational purposes.

During several years' observations, no effect of fog or other surface weather conditions has ever been noticed in wireless direction-finding, which is again fortunate for its use in navigation during times when visual observations are impracticable.

In the application of the direction-finder to aircraft, similar remarks apply as to its accuracy, with one important addition. When the direction-finder is operated on the ground on the transmissions from a machine in the air, the observed bearings are liable to error when the angle of elevation of the machine at the ground station exceeds a small value. This error is caused by the operation of downcoming waves on the direction-finder, but is evidently only appreciable for very short range transmission. The limited amount of experience with direction-finders used in the aircraft itself appears to show that these are destined to be of great service in the future of aerial navigation.

Turning now to other means by which directional wireless may be used in connexion with navigation, we have first the scheme which is practically an inversion of the above systems; that is, a rotating loop or its equivalent is used at the transmitting end and the reception of the signals is carried out on an ordinary aerial. When a closed loop or frame coil with its plane vertical is used for transmission purposes, the variation along the earth's surface is a maximum along a line through the plane of the coil and decreases according to a cosine law to a zero value along the axis of the coil. If, therefore, the coil is rotated about a vertical axis, the strength of signals received at a distance on an ordinary aerial will vary from a maximum when the coil is pointing towards the receiver to a minimum or zero value when it is at right angles thereto. In the practical operation of the device the coil transmitter is rotated at some convenient uniform rate, and arrangements are made for characteristic signals to be transmitted as the coil passes through two positions such as the north-south and east-west lines. By the use of a stop watch at the receiver, the times of rotation of the coil from one of these positions to the minimum signal position can be determined, together with the time of complete rotation. A simple calculation then serves to obtain the direction of the transmitting beacon from the receiver.

The great advantage of this system is that any ship or aircraft which is provided with a wireless receiver can obtain directional observations on these transmitters, and if a suitable distribution of the latter could be arranged, the method would be very useful for navigational purposes. Although it was developed in Germany before the War and an organisation of rotating beacon transmitters was set up, the system has of recent years only been used for experimental purposes, and its commercial application has still to be realised. It may be mentioned here that both this type of directional transmitter and the directional receiver referred to previously can be provided with a simple circuit modification which results in only one signal minimum being produced in a rotation of the coil through 360°. This "sense-finding" attachment results in the removal of the 180° ambiguity which is otherwise inherent in these methods.

The development and use of the above directional systems has been carried out on the wave-lengths chiefly used for communication purposes in aerial and marine wireless, *i.e.* approximately from 300 to 3000 metres. As a result of the development of the thermionic valve to a high degree for both transmission and reception purposes, it has become possible to extend the practice of wireless communication to very much shorter wave-lengths. Among the numerous vistas of development thereby opened up, not the least important is the practicability of resorting to the use of reflectors for concentrating the radiated energy in the required direction of transmission. By the use of suitable reflectors at both the transmitting and receiving end of a point-to-point communication link, the resulting concentration of wireless wave energy can be made equivalent to a magnification of several thousand times as compared with the ordinary transmitter which radiates its energy equally in all directions. This advantage, combined with the inherent properties which waves lying within certain bands of wave-lengths between 15 and 100 metres appear to possess for travelling through the upper atmosphere to great distances with very small attenuation, has already caused a revolution in ideas as to long-distance wireless communication. The resulting opening-up of a large number of fresh communication channels has come as a great boon to wireless engineers struggling with an already congested ether.

THE WIRELESS BEACON.

By the use of waves of length still shorter than those mentioned, it becomes possible to utilise another principle in applying directional wireless to navigation purposes. This consists in combining the aerial system of a wireless transmitter with a suitable reflector so that a fairly concentrated beam of wireless waves is sent out in one direction, which is varied by the regular rotation of the whole arrangement. We have here literally a wireless lighthouse, since it is exactly analogous to the rotating beam of light emitted by certain lighthouses around our coasts. Now it is a well-known optical law that for a reflector to be effective its dimensions must be at least comparable with the wave-length. Hence it is evident that for the rotation of the reflector to be at all practicable, the wave-length employed must be quite small.

In the two revolving beam transmitters which have been set up in the last year or two, the wave-length employed is about 6 metres. In the first station erected at Inchkeith, Firth of Forth, the aerial is a straight vertical wire erected in the focal line of a cylindrical parabolic reflector system of vertical wires. In the more recent station erected at the South Foreland, the aerial system comprises a number of energised aerials arranged in a plane, and in front of a similar parallel system of reflecting wires. The result in each case is the transmission of a beam of limited angle which is rotated uniformly at a rate of about one revolution per minute. Any ship fitted with a suitable receiver for the wave-length employed will then only receive signals as the beam flashes past its aerial. From the code signals heard the direction of the beam at that moment may be read from a simple chart. The range of the station is necessarily somewhat limited, owing to the great absorption of energy of such short waves by the earth. In experiments carried out a short time ago, it was claimed that a maximum range of 100 miles oversea could be obtained.

A great advantage possessed by this system over those previously mentioned is that it should be free from any errors due to its waves being deflected from the upper atmosphere. This fact may prove to be very important in securing a practical working range well in excess of that given by the waves travelling along the earth's surface. An advantage of the use of the short wave-length is the comparative freedom from interference which is experienced at the receiver. On the other hand, the use of such short waves may result in serious errors due to the coastal refraction effect previously mentioned, and to deviation of the waves by such obstacles as cliffs and buildings acting as reflectors.

Helium in Canada.

By Prof. J. C. McLennan, F.R.S., University of Toronto.

IN 1916, at the request of the Admiralty, and in collaboration with my colleagues, Profs. Satterly, Burton, and Dawes, I investigated the natural gases of Canada with the view of ascertaining the amount of their helium content. The gases with the highest helium content were found at that time to be in Ontario and in Alberta. In neither Province was any considerable supply of gas located that contained more than 0·36 per cent. of helium. During the years 1917–1920, with the assistance of Mr. John Patterson, of the Meteorological Office, Toronto, I designed and successfully constructed and operated a semi-commercial plant for extracting helium from natural gas. The gas we worked upon was obtained from an extensive field situated near Calgary, Alberta. During the operation of this plant we extracted in all from 15,000 to 20,000 cubic feet of helium having a purity of 90 per cent. When the Cryogenic Laboratory was instituted in the University of Toronto in 1922, the helium extracted at Calgary became available, and we succeeded in liquefying helium early in January 1923.

Since 1916 many new gas fields have been opened up in Canada, and about two years ago the Dominion Mines Branch decided to make a re-examination of the Canadian natural gases for helium. Mr. R. T. Elworthy was invited to undertake this task, and has carried it through most thoroughly and expeditiously. He found that in Alberta, while some of the natural gases contained less than 0·1 per cent. of helium, a number of them contained so much as 0·25 per cent. In some cases in this Province the helium content ran so high as 0·34 per cent. In New Brunswick none of the natural gases investigated was found to contain more than 0·064 per cent. In Ontario the natural gases varied considerably in their helium content. The gases of Lambton, Kent, and Essex Counties were found to contain not more than 0·15 per cent., while those in the counties of Brant, Haldiman, Lincoln, and Welland were found to have a helium content of from 0·25 per cent. to 0·35 per cent. In the County of Norfolk considerable supplies of gas were produced which ran from 0·4 per cent. to 0·5 per cent. in helium. The gas richest of all in helium was found in Peel County, the content being slightly more than 0·8 per cent. In this field three wells have already been sunk, and the gas is drawn from a horizon approximately 600 feet deep. The wells are consequently shallow, and though the gas supply is only moderate in amount, it has been estimated that the three wells will provide at least 100,000 cubic feet of helium per year.

With the view of rendering the supply of helium permanently available for research work in the University of Toronto, the Hon. the Premier of Ontario recently announced that, under an Order-in-Council, the Government of Ontario had secured, for the Crown, the products of the three wells mentioned, and the natural gas rights as well over a large block of land in the immediate neighbourhood of the wells.

The National Research Council of Canada has endorsed the policy adopted by the Government of Ontario, and is co-operating with the University of Toronto and other organisations in a scheme to establish a helium extraction station in the Peel County gas field, with the object of providing helium for research workers requiring the gas in Canada and probably in other parts of the British Empire as well.

It is fortunate that a supply of helium has been found in such a convenient locality—only some thirty-five miles from Toronto—for although the Government of the United States has extracted enormous amounts of helium from the natural gases of the Western States, its export from the United States is prohibited by law.

If we succeed in making the financial arrangements we have in mind, we hope to be in a position to provide, in the near future, ample supplies of helium for scientific investigations within the Empire.

Obituary.

Prof. J. G. M‘Kendrick, F.R.S.

EMERITUS-PROFESSOR JOHN GRAY M‘KENDRICK, who died in Glasgow on January 2, was born in Aberdeen in August 1841. By the death of his parents he was at a very early age thrown upon his own resources. When he was but thirteen years of age he was sent to spend a summer with his grandfather at Braco in Perthshire, where, herding sheep daily from 5 A.M. to 8 P.M., he learned to know and love the plants and the animals and Nature in all her moods. Zoology became M‘Kendrick's first scientific study; and the youth of seventeen actually demonstrated his little marine aquarium at a conversazione of the British Association which met in Aberdeen in 1859. Here he saw for the first time Faraday, Owen, Murchison and Huxley; science had begun to call him to herself.

Some one suggested that M‘Kendrick should qualify for the medical profession, and so, while still apprenticed to a lawyer in Aberdeen, he would rise at five and study until ten, when the duties of the desk claimed him for the day. After passing the "Medical Prelim." at Aberdeen, he went to Edinburgh in 1861 to enter upon the serious study of medicine. Here he heard Goodsir lecture; saw Turner and Joseph Bell ("Sherlock Holmes") demonstrate; listened to Simpson with his European reputation, to Laycock who was a psycho-analyst sixty years ago, and to Christison who was making toxicology a science. M‘Kendrick took Goodsir's medal in 1863, and was a prizeman in medicine, obstetrics and surgery. In 1864 he graduated M.D. with distinction at the University of Aberdeen. Years afterwards he summarised his medical course:—"no laboratories, no apparatus, no histology, no bacteriology, and *seven* different theories of inflammation."

After a few months at the Chester General Infirmary, M‘Kendrick obtained the position of surgeon to the

Eastern Dispensary in Whitechapel; and as he passed through London to take up his duties he saw the crowd witnessing the execution of Müller for the murder of Mr. Briggs in 1864. For the pain, squalor and vice of Whitechapel, M‘Kendrick exchanged the purity and serenity of Glen Nevis, for he became surgeon to the Belford Cottage Hospital at Fort William in 1865. It was in Lochaber that he met Hughes Bennett accidentally, and soon became his assistant. From 1870 until 1873, when Bennett's ill-health compelled him to winter abroad, M‘Kendrick had sole charge of the university classes at Edinburgh, which he conducted with marked success. Bennett resigned in 1873, and Rutherford was recalled from King's College, London, to fill the vacant chair, so that M‘Kendrick applied for and obtained the lectureship in physiology at Surgeons' Hall, and that at the Dick Veterinary College, Edinburgh. Here it was that he met James Dewar, with whom was begun that joint research which resulted in the discovery of the electric current produced in the retina and optic nerve when a beam of light was allowed to enter the eye.

For the first time in the history of physiology a current of action had been demonstrated in a sensory nerve by the normal stimulation of its end-organ. That Holmgren in Upsala made the same discovery about the same time was, of course, unknown to the Scottish workers. Dewar and M‘Kendrick also investigated the physiological action of chinoline and the pyridenes, becoming once more pioneers, this time in researches into the correlation between chemical structure and physiological effect. In 1872 M‘Kendrick visited Germany, and met Schultze, Pflüger, Du Bois-Raymond, Ludwig and Helmholtz. His "Life of Helmholtz" is perhaps his best piece of writing; it is an admirable account of a life with little incident in it apart from the scientific discoveries.

In 1876 M‘Kendrick was appointed to the chair of the Institutes of Medicine at the University of Glasgow; and here a Department of Physiology was created out of a lecture-room, a sphygmograph, a few microscopes and some diagrams.

M‘Kendrick was one of the most agreeable scientific lecturers Scotland has produced: his discourse had all the charm of a tale pleasantly told. In 1871 he had been elected a fellow of the Royal College of Physicians of Edinburgh. In 1881 he was appointed Fullerian professor of physiology at the Royal Institution, in which capacity he delivered many Friday evening discourses, as well as Christmas lectures to the children, and a valuable series on the history of physiology. In 1882 he received the degree of LL.D. from his Alma Mater; and two years later was elected into the Royal Society on the Council of which he afterwards served. He had been president of the Royal Society of Edinburgh, of the Section of Physiology of the British Association, of the Glasgow Philosophical Society; and he acted as examiner in a large number of universities. He delivered two courses of Thomson lectures at the Free Church College at Aberdeen.

M‘Kendrick wrote with ease; he was the author of the articles on ear, eye, senses, stereoscope, longevity and nervous system in the "Encyclopædia Britannica," as well as of "The Outlines of Physiology" published in 1878, and ten years later of a "Text-book" in two volumes splendidly illustrated. In conjunction with his assistant, Dr. Snodgrass, he wrote an interesting volume on "The Physiology of the Senses."

From 1892 onwards M‘Kendrick, who had always been interested in physiological acoustics, investigated the tracing on the surface of the wax cylinder of the phonograph by a photographic method. Later he devised an apparatus to eliminate the hissing sounds which mar the music reproduced by that instrument. M‘Kendrick was very fond of music, of poetry and of animals. He published a volume of devotional verse. His disposition was that of a deeply religious and reverent man who, though enjoying fun, disliked frivolity. His sympathies were wide, his friendships many, his capacity for bringing the best out of every one conspicuous. He urged moderation in the use of strong drink; some of his best addresses are those dealing with this subject.

M‘Kendrick married in 1867 a daughter of W. Souttar of Aberdeen, who died in 1898. He is survived by two sons—Dr. J. S. M‘Kendrick of Glasgow, and Colonel Anderson M‘Kendrick, I.M.S. (retired), director of the Laboratory of the Royal Colleges at Edinburgh—and by one daughter.

D. Fraser Harris.

We regret to announce the following deaths:

Prof. E. G. Browne, Sir Thomas Adams professor of Arabic in the University of Cambridge and fellow and president of Pembroke College, known for his work on Persian literature and on the history and literature of oriental religions, on January 5, aged sixty-three years.

Dr. R. Caton, C.B.E., pro-chancellor and emeritus professor of physiology in the University of Liverpool, and vice-chairman of the Liverpool School of Tropical Medicine, on January 2.

Rev. George Henslow, lately professor of botany to the Royal Horticultural Society, and from 1882 until 1904 president of the Ealing Natural History Society, on December 30, aged ninety years.

Prof. Martin Kirchner, who was prominently associated with the anti-tuberculosis campaign and with the framing of the German laws relating to infectious diseases, on November 11, aged seventy-one years.

Mr. Frank Morey, honorary curator of the Prince Henry of Battenburg Memorial Museum at Carisbrooke Castle, Isle of Wight, and editor and joint author of "The Guide to the Natural History of the Isle of Wight," on December 29, aged sixty-seven years.

Dr. James Murie, formerly assistant-secretary and librarian of the Linnean Society, and naturalist to Consul Petherick's expedition of 1861 to Gondokoro, on December 21, aged ninety-five years.

Erratum.—Mr. Edgar R. Waite, the Director of the South Australian Museum, Adelaide, informs us that the details given in the obituary announcement referring to Mr. A. R. McCulloch, which appeared in Nature of October 24, 1925, p. 620, are incorrect. Mr. McCulloch was zoologist at the Australian Museum, Sydney, where he devoted himself to research on fishes and crustaceans, and his death occurred on August 31, at the age of about thirty-eight years.

News and Views.

PROF. W. GARSTANG, whose address on "Wordsworth's Interpretation of Nature" is published as a Supplement to this week's issue of NATURE, is both a naturalist and a poet, and is therefore appropriately equipped as an exponent of one who made Nature and man his chief poetic theme. Wordsworth felt himself to be a great high priest of Nature, and his spiritual insight was deep and penetrating. In the application of scientific truth to poetic purpose, he was as accurate and trustworthy as Tennyson, but not so rich or minute in his allusions to scientific knowledge. We do not for a moment suggest that the worth of poetry can be measured by the use made of such knowledge, but new natural phenomena and conceptions can extend the range of poetic thought and inspire that emotion which expresses itself in enduring verse. "Poetry," said Wordsworth, "is emotion recollected in tranquility," and it differs from science in being the expression of individual feeling as an end in itself and not as a means of securing general assent to particular conceptions or interpretations of the theme. There is plenty of imagination in science, but it is disciplined and unemotional, and is put to the test of observation with the view of arriving at natural truths, whereas in poetry its object is the communication of pleasure by beautiful phrase or creative fancy. In ornithology there is but one description of the skylark, but in poetry there are scores, and each has a note of its own. That is why we find such poets as Keats, Shelley and Wordsworth interpreting the aspects and operations of Nature in ways that are differently beautiful. Keats by sympathetic human imagery, Shelley by changefulness and its symbolism, and Wordsworth by richness of allusions to everyday aspects of natural objects and events. We are sure that Prof. Garstang's illustrations of Wordsworth's style and genius will be read with pleasure by lovers of literature as well as of science.

THE searchlight of public opinion begins to shine upon the mathematical tripos. A few days ago Prof. G. H. Hardy, in his presidential address to the Mathematical Association, gave it as his considered opinion that the tripos should be abolished. It is not because mathematics are in a better state at Oxford than at Cambridge that he directs his fire against his old university and not his new one, it is because the Cambridge examination is the more important one. Prof. Hardy considers that the nature of the mathematical tripos examination prevents any serious study of mathematics and causes candidates to spend their time learning tripos tricks instead. So bad is the effect of this that among mathematicians of world fame, we produce only about a twentieth of the number that our record in more wholesome times would entitle us to expect. To determine whether a candidate is worthy of a degree, Prof. Hardy would require him to send in a dissertation and judge him upon that. He would in fact adopt the usual continental method. This method of a degree by thesis is also not unknown in Great Britain. Most of our universities allow it as a method for higher degrees. Most of them it is true require the first degree to be by examination, and only in the London B.Sc. do we find an instance of a first degree that can be obtained by thesis.

PROF. HARDY'S cure is a more drastic one than that proposed in our leading article of May 10, 1924, p. 665, entitled "Mathematical Physics in University and School." In that article we proposed to broaden the mathematician's studies by including physics, and to make this possible in the three years at the disposal of the student by the severest pruning of both mathematics and physics. Now pruning is always a delicate and difficult operation, and we are inclined to believe that Prof. Hardy's cure is a better one. It has, moreover, the advantage of mending ills that we had not considered. Our complaint was only against the narrowness of the range of the mathematician's studies, his is against the method of treatment of the whole subject. A system in which a candidate, after taking the first part of the mathematical tripos, would be allowed to show up a dissertation instead of taking the second part, is no great departure from the traditions of British universities, since they do already in certain cases allow degrees by thesis. To aim at such a system would seem an appropriate first objective; and when such a system had been adopted and had had some years trial, it would be time enough to consider whether it was right or wise to go further and allow an alternative also to the first part of the examination.

FOR the meeting of the British Association in Oxford, August 4-11, under the presidency of the Prince of Wales, the Council has appointed the following sectional presidents: Section A (Mathematics and Physics), Prof. A. Fowler, professor of astrophysics in the Imperial College of Science and Technology; Section B (Chemistry), Dr. J. F. Thorpe, Yarrow research professor of the Royal Society and professor of organic chemistry in the Imperial College of Science and Technology; Section C (Geology), Dr. S. H. Reynolds, professor of geology in the University of Bristol; Section D (Zoology), Prof. J. Graham Kerr, regius professor of zoology in the University of Glasgow; Section E (Geography), the Hon. W. Ormsby-Gore, M.P., Colonial Office; Section F (Economics), Sir Josiah Stamp; Section H (Anthropology), Dr. J. H. Fleure, professor of geography and anthropology in University College, Aberystwyth; Section I (Physiology), Prof. J. B. Leathes, professor of physiology in the University of Sheffield; Section J (Psychology), Dr. J. Drever, reader in psychology in the University of Edinburgh; Section K (Botany), Dr. W. Bateson, director of the John Innes Horticultural Institution; Section L (Education), Sir Thomas Holland, rector of the Imperial College of Science and Technology; Section M (Agriculture), Sir Daniel Hall, chief scientific adviser to the Ministry of Agriculture. The name of the president of Section G (Engineering) will be announced later.

THE extent to which the technical intelligence service attached to the manufacturing community of Great Britain has been augmented since the War by the new industrial research associations is well illustrated in a paper read before the Institution of the Rubber Industry on December 7 by Dr. S. S. Pickles, the Chairman of the Library Committee of the Research Association of British Rubber and Tyre Manufacturers. The paper dealt with the importance of such a service to the rubber industry, and described some of the work that the Rubber Research Association is doing in this respect. In the short period of its existence the Association has built up a Library which not only possesses a representative reference collection of books, pamphlets, and periodicals (claimed by Dr. Pickles to be without an equal in Great Britain), but also acts as a very complete information bureau on all matters relating to the rubber industry and trade. The Library is provided with a comprehensive classified card index to the contents, which enables it at short notice to supply references to all published information on any branch of the subject, and in addition issues monthly to all its members a *Summary of Current Information* in which are given more or less lengthy abstracts of articles appearing in the scientific and technical press, and of English and foreign patents, notices of new publications and of book reviews, and lists of English patent applications and acceptances. The size of this publication, which will comprise well over 400 pages for the current year, shows how increasingly serious a problem it is for the specialist to keep in touch with what others are doing in the same field, and emphasises once more the vital necessity for the provision of adequate compilations of this nature in all branches of science and technology. Some of the best work in this direction being done at the present time lies to the credit of the research associations, and though the records are not usually available to the general public, their circulation amongst the majority of those intimately connected with the industries concerned cannot but have far-reaching results.

THE use of hydrogen in large-scale chemical manufacture is a comparatively recent development, of which the importance is growing rapidly. Production of synthetic ammonia entails the greatest consumption, but large quantities are also used for hydrogenating liquid oils to convert them into solid, edible fats. The manufacture of hydrogen for the latter purpose was discussed at a meeting of the Chemical Engineering Group of the Society of Chemical Industry on January 8, when Mr. A. E. Knowles read a paper on the electrolytic method of production. The Lane process of making hydrogen, by passing steam over heated iron or a carbonaceous iron-ore and then reducing the iron oxide with water-gas, has fallen out of use for economic reasons, and the Haber-Bosch process of passing water-gas and superheated steam under pressure over a catalyst, though cheaper than any other, is unsuited for producing hydrogen to be used for hydrogenation, because it is always contaminated by much nitrogen. In Mr. Knowles's opinion, the electrolysis of distilled water is alone suitable, and in his paper he described in detail the electrolytic plants in use at Port Bromboro', in Cheshire, and at Bussi, in Italy. The outstanding merits of this process are great purity of the hydrogen, economy in labour and wear and tear of plant, no leakages of electricity or gases, and very cheap production, if cheap electricity is available, and if there is a ready market for the by-product oxygen. Dr. A. C Thaysen's paper on the production of hydrogen by micro-organisms summarised the history of this method, and gave data concerning the process used in the Royal Naval Cordite Factory at Holton Heath during the War for making acetone by fermenting maize-starch and other amylaceous material. This process yields, in addition to acetone, *n*-butyl alcohol, organic acids, and carbon dioxide, 1·60 per cent. of hydrogen, or 5·5 cubic feet per lb. of grain fermented. A comparatively small plant consuming 20 tons of grain per day produced about 250,000 cub. ft. of this gas at an estimated cost of about 2*s*. per 1000 cub. ft. for collection and purification. Both the electrolytic and the fermentation processes are of especial interest, because they do not involve the use of any fuel.

CAPTAIN P. P. ECKERSLEY, the engineer to the British Broadcasting Company, gave an interesting lecture on January 7 to the Institution of Electrical Engineers on "Past, Present, and Future Development in Wireless Telephony." As a means of communication between individuals, Capt. Eckersley does not anticipate any rapid development in radio telephony, the future of the art will lie mainly in its applications to broadcasting. If in Great Britain at the present time, we connect a microphone with the net-work of wires each of which terminates at a transmitting station, then one voice can be heard simultaneously by ten million people. In Capt. Eckersley's opinion, a final scheme for Great Britain would rely on line relay stations at Glasgow, Leeds, London, and possibly Bristol or Gloucester. The other stations would be connected with these by suitable land wires. The system would be completed by interconnecting Glasgow with Leeds, Leeds with London, and London with Bristol by trunk lines. Future development seems to be leading in the direction of a few stations having large power outputs. Owing to the fact that only about 100 wave-lengths are available for broadcasting, the allocation of them internationally is still a vexed question. He had recently suggested that 82 of them should be allocated to the most important stations, and that sixteen wave-lengths should be reserved for group working. By suitably distributing these sixteen wave-lengths amongst stations of moderate power, there would be little serious interference. If stations could work on exactly the same wave-length, no heterodyne note would be audible. The difficulties in the way are great, but Capt. Eckersley has hopes that they will be overcome. In choosing a site for substations in Great Britain, the criterion must be the crystal set. If the listener can receive broadcasting on a crystal set from a given station, there will be little risk of him suffering appreciably from interference.

THE present exhibit in the house devoted to objects of special interest at the Royal Botanic Gardens, Kew, illustrates living plants of economic value. It includes plants which produce rubber, balata and chicle gum, and a Wardian case packed with young para rubber plants is also exhibited in order to illustrate the manner in which the para rubber and other economic plants have been sent from Kew to all parts of the Empire. Plants of tea, coffee, cacao, and Paraguay tea (the Yerbe de Maté) are examples of the plants yielding beverages. Amongst the fibre-producing plants shown are sisal (Agave), silk grass, China grass or ramie, Manila hemp (*Musa textilis*), Mauritius hemp (Furcræa), and the palm yielding raffia or bass (*Raphia vinifera*). Timbers are represented by young plants of teak, the true mahogany (Swietenia) from Honduras, West African mahogany (Khaya), and West African cedar. Other plants of economic importance exhibited are those yielding cocaine, quinine, ipecacuanha, eucalyptus oil, cloves, cinnamon, camphor, olives and pepper. A plant is also shown of *Tarahtogenos Kurzii*, one of the sources of chaulmoogra oil, which is now being used in the treatment of leprosy. The notices with the plants indicate their countries of origin and also the part which has been played by the Royal Botanic Gardens, Kew, in introducing such plants of economic value to the various parts of the British Empire.

ON December 18 Prof. T. H. Havelock read an interesting paper before the North-East Coast Institution of Engineers and Shipbuilders on "Some Aspects of the Theory of Ship Waves and Wave Resistance" The first two sections of the paper must be of great interest to those who, engrossed in the more immediately practical problems that present themselves, have not the opportunity of studying the mathematical theory for themselves or of keeping abreast of its developments. In the first section, it is shown how calculations with travelling pressure disturbances illustrate such problems as the variation of wave resistance with speed, the interference of bow and stern waves and the effect of shallow water. In the second section, the hull of the ship is regarded as equivalent to a certain distribution of sources and sinks in the fluid and this enables such questions as the effect of the form of the water-line section, the length of the parallel middle body, and the effect of variations in draught to be treated. Some notes on the detailed mathematical calculations as they have appeared in Prof. Havelock's published papers is dealt with in an appendix. It is not claimed that the theory has reached a stage at which any new and important practical results can yet be deduced but rather that the general conformity of the conclusions from a pure hydrodynamical theory with known practice is satisfactory from the point of view of future development.

WE regret to learn from the *Chemiker-Zeitung* that a fatal accident has been caused by the unexpected explosion of a mixture of carbon disulphide and liquid air. Organic liquids of many different types, *e.g.* ether, chloroform, ethyl acetate, petroleum, pyridine, etc., have been employed at various times in conjunction with liquid air for the purpose of preparing freezing mixtures, and, so far, explosions have only resulted when carbon disulphide has been used. When this substance is dropped into liquid air there is formed on the surface a crust which may hinder evaporation and thereby cause an explosion unless the crust be pierced as quickly as it is formed. There appears, however, to be some further cause of instability, which has not yet been explained. Prof. W. Biltz, of the Technische Hochschule in Hannover, states that on November 16 a skilled experimenter, Dr. Asbrand, was preparing the mixture in a Dewar flask and had carefully observed all the usual precautions, when the flask suddenly exploded. He was severely hurt, and he succumbed to his injuries on November 28. Dr. Asbrand, who was only twenty-eight years of age, had studied at the University of Göttingen and later at Rostock under Prof. Walden. He had only commenced work at Hannover at the beginning of the present academic year.

MR. DAVID GREENHILL, the Director and General Manager of the Sun Engraving Company, in a lecture before the Royal Society of Arts (published in the Society's journal, December 25), said that colour printing of to-day is done chiefly by lithography, offset, and the three-colour process, the last almost exclusively by letterpress methods, though the photographic principle of the three-colour process is being increasingly used to develop offset work, and also more recently to develop photogravure in colour. The three-colour process is certainly the greatest advance in colour printing of recent years, and with scientific photography and colour selection, skilful fine etching, and very careful machining or printing, it seems to be capable of reproducing almost anything in the way of pictorial representations in colour. The lecturer claimed for British photo-engravers and printers the first place in quality of three-colour process work, though our position is successfully contested in America, Germany, and France, except perhaps in the fine attention to detail and finish. Photogravure, "the most beautiful method of printing yet evolved," has made more rapid strides abroad than Great Britain. It promises to solve the paper difficulty of the letterpress method, which needs a smooth surface, as it readily gives fine results on almost any uncoated paper, and it overcomes various difficulties connected with the inks used in the letterpress method.

IT was suggested in a paragraph in NATURE of January 2, p. 25, that platinised glass might be used instead of neutral tinted glass for solar telescope work. Messrs. Hawksley and Sons, 83 Wigmore Street, Cavendish Square, London, W.1, write to say that they are in a position to supply platinised glass discs of various densities. The Rheinberg methods are employed.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A professor of political science at the London School of

Economics—The Academic Registrar, University of London, South Kensington, S.W.7 (January 22). A medical superintendent in the Infectious Hospitals Service of the Metropolitan Asylums Board—Clerk to the Metropolitan Asylums Board, Victoria Embankment, E.C.4 (January 26). An electrical engineer and electric inspector for the public works department of the Government of Bihar and Orissa—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (January 29). An assistant engineer and a junior assistant engineer at the Fuel Research Station, East Greenwich, for research work in connexion with coal purification and internal combustion engines respectively—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, S.W.1 (January 30). A forestry inspector in the Lands and Agriculture Department of the Irish Free State—The Secretary, Civil Service Commission, 33 St. Stephen's Green, Dublin (January 30). Sir Ernest Cassel readerships in economic geography and in foreign trade at the London School of Economics—The Academic Registrar, University of London, South Kensington, S.W.7 (March 9). A director of research in animal diseases under the Animal Diseases Research Association—The Secretary, 83 Buccleuch Street, Glasgow (March 27). A computer for the Cadastral Framework Party, Gold Coast Survey Department—Crown Agents for the Colonies, 4 Millbank, S.W.1 (quoting M/13965). A chief engineer for the Public Works Department of the Government of Nyasaland—Crown Agents for the Colonies, 4 Millbank, S.W.1 (quoting M/14046).

Our Astronomical Column.

The Total Eclipse of the Sun, January 14.—It is hoped that fine weather has favoured the various expeditions sent to stations on the path of totality passing from East Africa across the Indian Ocean to Sumatra and Borneo. One matter of interest is the shape of the corona, which is known to vary in a cyclical manner with the sunspots, flocculi, and prominences. This eclipse, occurring about midway between sunspot minimum and maximum, may be expected to show a type of corona which is intermediate between the characteristic minimum type, with polar "brushes" and extended equatorial streamers, and that of the maximum type in which the distribution of the corona is more concentric with the sun's disc.

The finer details of the inner corona have sometimes been observed to show local structures which were apparently related either to sunspots, flocculi, or prominences near the limb at the time of eclipse. It may be noted that, on January 14, the region of the sun containing the large sunspots which crossed the central meridian on December 25, was within a short distance of the limb at position angle 106° east of the north point of the disc.

The January Meteoric Shower.—Mr. W. F. Denning writes: "The weather proved unfavourable for observation on January 3. There were, however, a few brief intervals of clear sky between successive storms at Bristol. About 20 meteors, including 17 Quadrantids, were observed, and they were mostly brilliant objects with long flights and fairly slow motion. The largest meteors were seen at $6^h\ 16^m$, $6^h\ 21^m$ and $6^h\ 50^m$. At $7^h\ 18^m$ P.M. a fine object with exceedingly slow motion was seen in Gemini and directed from a southern radiant near γ Eridani. Later in the night the sky was more or less clouded, though there were temporary clearances and occasional meteors were observed.

"At $9^h\ 52^m$ P.M. a fireball was viewed from various south-western stations falling in the northern sky. It was directed from a region of the heavens opposite to that in which the radiant of the Quadrantids was situated. Mr. Corder of Bridgwater observed this object and described it as quite equal to Venus; emerald green in colour with a red flash at the end. Several observers saw the meteor from Bristol, and I am collecting details with the view of finding the height, velocity, and radiant point.

"On January 4 unsettled weather continued and the prevalence of clouds frequently interrupted watching. Among the meteors observed were five certain Quadrantids, thus proving the shower's active sustenance. In fact, the evidence obtained this year strongly indicates that this display has lengthened its visible duration in recent times. In 1880, 1886, and some other years, extreme brevity appeared to be a characteristic feature of the shower's richer phase, though occasional shots were directed from the same radiant on later nights of the month, certainly to January 15."

The New Greenwich Sidereal Clock.—The new clock by Short with a free and a slave pendulum, the former in an airtight case, has now been in use for a year, and Mr. W. Bowyer contributed a paper to the Royal Astronomical Society, which was read at the meeting on January 8, in which the performance of the clock is described and analysed.

The rate at the beginning of 1925 was very small, but gradually increased, owing partly to a slight amount of air leakage into the case, which necessitated reduction of the air pressure on one or two occasions.

The clock error could be expressed very exactly by an expression of the form $a + bt + ct^2$. The quantity c remained uniform from January until August, when it underwent a notable reduction, the cause of which is unexplained. It retained the new value until the end of the year.

Dr. Jackson noted that the clock performs so well that it raises the question whether we should not make sidereal time vary uniformly, *i.e.* reckon it from the mean equinox instead of the true, which is affected by nutation. The rate of the former clock was not uniform enough to make the difference an important one.

Star Fission and Cepheid Variability.—Dr. Jeans read a paper at the January 8 meeting of the Royal Astronomical Society, in which he elaborated the suggestion made at the previous meeting that Cepheid variables might be stars in which the process of fission was in progress but uncompleted. He gave an estimate of the duration of this stage as compared with the whole life of the star, and concluded that the result accorded with the observed number of Cepheids. He enumerated several points in which the new theory seemed to fit the facts better than the pulsation theory. The latter seemed to require too large a time-lag for the heat produced by compression in the star's interior to reach the surface. Also he found it difficult to picture the whole star pulsating in a single period. He would rather have expected a complex curve like that arising from the striking of several adjacent notes on the piano.

Prof. Eddington continued to defend the pulsation theory, so the matter is one for further discussion and consideration.

Research Items.

THE MAXIMUM POSSIBLE POPULATION OF THE WORLD.—Sir George H. Knibbs concludes in *Scientia* (Nov. 1925) his examination of the world-problems of population, with special reference to the conditions governing the maximum possible population. He gives various estimates (based upon certain considerations) of the possible population ranging from 2942 millions—if the world's existing population increased in ratio of O. R. Baker's estimate of possible increase in the U.S. agricultural area—to 9792 millions—if all existing arable land in the world could support three persons per acre—and a final maximum of 13,440 millions if an average of a person per 2½ acres applied to the whole land surface of the world. But, as he points out, any one estimate is unsatisfactory, because the possible number must depend upon the world's social and economic organisation, upon ethical considerations governing these, and upon the extension of man's knowledge of Nature, and he briefly examines some of the main issues. Assuming that the present standard of living is retained, together with the present national prejudices and egoisms, Sir George considers it doubtful whether the population will ever reach the 5000 million limit. If man better co-ordinates his efforts so as to involve less expense in non-productive effort, then possibly the advance of science may enable the 7000 million limit to be reached. The friendly study of universal economic conditions and of the adjustment of all territorial and economic relations, together with the advances made through systematised knowledge, would perhaps make possible a population of 9000 millions, though this would leave only a small area available to each individual.

JAVANESE ARCHITECTURE.—In December 1924 at a conference of the Java Institute held at Jogjakarta, one of the questions discussed was the value of the ancient Javanese monuments for the present and future Javanese culture. A report of the discussion appears in a translation by Mary A. Rus in the *Indian Antiquary* for December. Among the speakers, Mr. Maclaine Pont enforced his argument by an analysis of the native and foreign elements in Javanese architecture. The Javanese monuments have many special features which are absent from the Indian buildings, such as the Hala head, the Makara, the spouts. The strong personal element in Indian images gives way in Java to a stereotyped "loveliness." Javanese style is elegant, correct, and accurately balanced, while the Indian is overloaded, overpoweringly vital, more solid, but not pure. The great buildings in Java coincide in date with the struggle for supremacy of the two great dynasties of Palembang and Java, but they represent the spiritual aspirations of a people rather than the feeling of Hindu rulers and upper classes. There must have been an architecture in Java resembling the primitive Jameh style before the Hindu dynasties came. It may be assumed that the Hindu dynasties gained their power in the first instance by missionary propaganda which developed canonical architecture in accordance with Indian proportional outlines. The style of the Javanese school perhaps originated from Central Asia through Indo-China. A close study of the reliefs of the great temple of Borobudur reveals that the sculptors had not the slightest knowledge of Indian structure; that in illustrating Hindu tales, they pictured the persons in complete Javanese surroundings, and this convention was accepted by both priestly and civil builders. The conclusion, therefore, is that influence was brought to bear on Javanese compositions by Hindu rulers and priests who had themselves no technical knowledge.

INDIA AND THE PACIFIC.—In the *Ceylon Journal of Science*, vol. 1, Pt. 2, Capt. A. M. Hocart marshals in some detail the evidence which, in his view, points to an explanation of the similarities of culture in India and in Fiji as due not to a convergence from a distinct origin, but as being essential elements of a resemblance which could only be due to derivation from a common prototype. The points to which he refers are the cross-cousin system with a common *religious* background as shown in certain ritual practices connected with that relationship, a social organisation with a dichotomous system in each case on Capt. Hocart's interpretation, the relation of the elements within the two caste systems, succession and chieftainship and their attendant rituals and the ceremony of fire walking. Certain divergences are to be explained as due to a simplification that has taken place in Fiji. On the whole, Fijian culture is more archaic and is not to be derived from that of the Vedic literature. It is suggested that this pre-Vedic culture may have been carried to the Pacific by a Mongoloid element of North India, which was partly swamped by the aborigines, partly pushed back into the Himalayas and eastward by western invaders. It is at least certain that everything in south Asia is farther east than it was, and the spread of pre-Vedic culture to the Pacific is merely an episode in a great retreat of people along the southern shores of the Asiatic continent and into the islands.

TRIAL AND ERROR IN THE BEHAVIOUR OF CERTAIN ARTHROPODA.—Prof. W. E. Agar gives an account (*Australian Journ. Exp. Biol. and Medical Science*, Vol. 2, Part 3, 1925) of observations on the behaviour of several arthropods, which were placed in conditions unfavourable to their normal activities, from which in each case there were two apparent avenues of escape—one actually leading to freedom, but the other ending in a cul-de-sac and thus failing to afford relief. In the majority of the experiments the animal was placed in the stem of a Y-shaped passage and when it arrived at the bifurcation had to make a choice between the right or left branches. Experiments with Daphnia involving more than 1400 trials failed to reveal any power on the part of the animal to learn by experience, and a similar finding is recorded for water mites. Young crayfish (Parachæraps) gave very different results, soon learning to avoid the wrong passage and to take the right one, *e.g.* in one experiment in which entry into the wrong passage, besides failing to bring freedom, resulted in an electric shock, the animal took the wrong (left) turn at its first trial but then chose the right passage seven consecutive times. The electrodes were then transferred to the right-hand passage and the animal continued to go into this passage for eight more times, receiving a shock each time, but out of the next twenty-one times made the correct choice nineteen times. The difference of intelligence may perhaps be correlated with the modes of life—the crayfish searches out its food by means of its sense organs, while Daphnia has far less initiative, feeding on microscopic organisms collected by a current of water produced by the movement of certain appendages, and shows no evidence of awareness of other animals or bodies.

HERRING INVESTIGATIONS.—The report for 1924–1925 of the Dove Marine Laboratory, Cullercoats, Northumberland, edited by Prof. A. Meek, contains further investigations on herrings from various localities by Mr. B. Storrow, who, in continuing his work of previous years, finds that the fish hatched in 1920 formed the bulk of the catches from the Shetlands, Firth of Forth, and the north of Scotland. Those caught inside the Forth consisted mainly of much younger fish than those caught south of its entrance; a fact regarded as indicative of a southerly migration for spawning. The author believes that there is again evidence pointing to extended migration from the North Sea and the north-west of Ireland to oceanic waters, and there are possibly similar indications from the south-west of England, but the small number of herrings examined from Milford Haven and St. Ives makes this latter statement very uncertain. He sums up with the following words: "Our work points to migrations from seas to or towards the ocean, and return migrations towards or into seas for spawning." Mrs. Cowan adds data dealing with the size of these same samples. In the faunistic notes the spawning of the lug-worm *Arenicola Marina* is described. White patches were seen in the water towards the end of September 1924, in ripple marks on Cullercoats sands, which proved to be masses of sperms, and the worms were found close to the patches. Most of those examined had already spawned, and on the next day all the worms had disappeared. This probably represented the end of the autumn spawning.

SPECTRAL PHOTOMETRY.—The issue of the *Physikalische Zeitschrift* for December 8 contains a report by Dr. H. B. Dorgelo, of the Scientific Laboratory of the Philips Electric Lamp Works, Eindhoven, Holland, on the recent progress in the methods of determining the intensities of spectral lines by photography. He deals first with the expression of the blackening of a photographic plate as a function of the intensity of the light falling on it and the time of exposure. Then follows a section on the comparison of the intensities of the lines of a narrow group in a photograph by means of photometers and the use of semi-transparent wedges of platinum deposited on quartz as absorbers. For lines far apart it is necessary to compare the photograph of each with that produced by a standard source of light for which the relation between energy emitted, wave-length, and blackening produced is known. Several sources, including the tungsten incandescent lamp, are discussed and the various types of spectro-photometers are considered. Some of the most striking results of observations are given, with references to nearly a hundred papers, mainly of recent date.

THE VELOCITY OF SECONDARY CATHODE RAYS.—The results of an investigation, in which homogeneous cathode rays are made to fall on a blackened metal surface and the secondary cathode rays are retarded by an opposing electrostatic field, are given in a paper by Dr. A. Becker in the November *Annalen der Physik*. It is shown that the secondary electrons are, in general, considerably more numerous than the primary electrons of similar low velocities reflected or diffused backward, so that it is not difficult to determine the manner of emission of the former. The velocity distribution proves to be identical with that of the δ-radiation. The most probable exit velocity, and therefore the absolute value of all the secondary velocities in the cases investigated, is independent of the velocity of the primary rays; there are signs of a decrease at 24 volts, when the limiting velocity for the excitation of secondary radiation is approached. The most probable velocity of the secondary rays is about 2 volts, which agrees with that found for δ-rays. This velocity depends on the nature of the atom in which the secondary ray originates, and it is on the atom that the amount of energy abstracted from the primary corpuscular ray depends. The results fit in perfectly with the views of Lenard on secondary radiation.

THE PRESERVATION OF FRUIT.—B. T. P. Barker and O. Grove discuss a valuable practical application of sulphur dioxide for the preservation of fruit for subsequent use in jam making or as cooked fruit in the home, in the *Journal of Pomology and Horticultural Science* for December. Starting from the problem as to how to preserve pulped fruit put aside at periods of pressure until its conversion into jam is practically convenient, they have reached the conclusion that a better method of preservation of the fruit is to drop it direct into a 0·08-0·1 per cent. solution of sulphur dioxide in an air-tight container. Red fruits in particular lose their colour, but this is largely though not completely restored on boiling, and the skin of gooseberries and currants is toughened as the result of the treatment, but otherwise fruit so treated seems little if at all inferior to fresh fruit for subsequent cooking purposes, and the sulphur dioxide, being volatile, is driven off on boiling. The method therefore seems likely to supersede pulping for the jam manufacturer, whilst in the home, if used with suitable precautions, it may replace the somewhat more troublesome process of bottling in sterile, air-tight containers.

CHEMISTRY IN THE ARTHAŚÂSTRA.—In two recent issues of the *Chemiker Zeitung* (Nos. 134 and 135, 1925) Prof. E. O. von Lippmann deals with those sections of the Arthaśâstra which are of scientific interest. The text of the Arthaśâstra has only comparatively recently come to light; it has been translated into English by Dr. R. Shamasastry, whose edition is that upon which Prof. von Lippmann has worked. The Arthaśâstra is ascribed to an author of the name Kautilya, who lived in the time of King Chandragupta (321-296 B.C.); it deals with problems and methods of government and administration and is largely compiled from more ancient works of a similar character. The latter fact is of particular importance, since it enables us to get an idea of political and administrative conditions in India in a pre-Buddhist age. In the course of the book many facts of scientific interest are mentioned incidentally; these Prof. von Lippmann has gathered together and enriched with annotations. Among the metals gold takes the first place. It is of two kinds—river (alluvial) gold and rock gold. The pure metal is yellow, brilliant, heavy, and very malleable, and on the touchstone gives a characteristic streak. If impure, gold may be purified by fusing it with an appropriate quantity of lead and afterwards treating it with cow-dung and oil. By melting gold with 1 to 15 parts out of 16 of copper, 16 standard alloys can be obtained; these give streaks which can be compared with those of unknown alloys, and thus the composition of the latter may be ascertained. Pure silver is white, shining, and malleable; if it contains impurities, these may be removed by melting the metal with a quarter of its weight of lead. The most important remaining metals are copper (*tâmra*), lead (*sîsa*), tin (*trapu*), iron (*kâlayâsa*), bronze (*kâmsya*), brass (*ârakûta*), *vṛtta* or *vritta* (?), and *vaikṛntaka*. Other substances described are salt (*kshâra*), alum (*sphatika*), borax, blue vitriol (*tîkshna*), and green vitriol (*kâsîsa*). On heating the latter a poisonous vapour with a strong smell is obtained. A number of plant and animal products are also mentioned, together with several poisons (*yôgapâna*). Although fermented liquors are discussed at some length, there is no indication that alcohol was recognised as a distinct substance.

The Physical and Optical Societies' Exhibition.

THE sixteenth annual Exhibition of Electrical, Optical, and other Physical Apparatus held by the Physical Society of London and the Optical Society on January 5, 6, and 7, was marked by a new departure which added greatly to its interest and popularity. In addition to the trade display of scientific apparatus, a number of demonstrations were provided in illustration of typical results of modern research and new or improved laboratory methods, together with lecture experiments and repetitions of famous historical experiments. After the admission of ticket-holders for the usual two days, the Exhibition was thrown open to the general public for a further day, and the available accommodation at the Imperial College of Science and Technology, South Kensington, was fully occupied throughout. There can be no doubt as to the success of the new section, and it is to be hoped that in future years it may be greatly extended. It makes considerable demands on the time of those who take part in it, as the experiments have to be carefully prepared, but public spirit of this kind has never been lacking amongst physicists. Prof. A. O. Rankine must be congratulated on the feat of organisation which he achieved, and mention must be made of the excellent illustrated catalogue, containing brief descriptions of the more important exhibits, which is now printed in a form suitable for inclusion in the bound volumes of the Proceedings of the two Societies.

In the historical section, pride of place must be given to a repetition of some of Newton's fundamental experiments in optics, prepared by Prof. F. J. Cheshire and Mr. B. K. Johnston. Elaborate care was taken to reproduce the original conditions as closely as possible, and an artificial sun was employed, comprising a source of light to which the required angular diameter was imparted by means of a lens system. Sir William Bragg illustrated Faraday's discovery of electromagnetic induction with apparatus which included the coil actually used by Faraday, and Mr. F. E. Smith showed the British Association rotating coil with which Maxwell measured resistance in primary units.

Amongst the more striking lecture experiments may be mentioned those by Mr. G. L. Addenbrooke on electrostatic attraction and by Dr. L. C. Martin on the polarisation of light. In the former, one sparking-ball of a Wimshurst machine is located over a saucerful of castor oil, a few millimetres above the surface. When the machine is operated, a column of oil rises up and adheres to the ball so long as the latter remains charged. In Dr. Martin's experiment, a beam of plane-polarised light is reflected vertically downwards through a sugar solution clouded by particles in suspension. Since the scattered light is seen with maximum intensity in the plane in which it is polarised, and this plane is rotated by the solution at different rates for different colours, the colour of the beam appears to change along its length. A current weigher designed by Mr. F. E. Smith should be of value in getting students interested in the subject of absolute measurements. It comprises a large fixed vertical coil, and a small central horizontal coil which swings about the horizontal diameter of the former. The current to be measured is passed through the two coils in series and the resulting torque is balanced by weights added to a scale pan, which is attached to the moving coil at a suitable distance from its axis.

The research section comprised exhibits by the more important research departments maintained by the Government and by industrial firms. An interesting item in the Admiralty's contribution was the piezo-electric oscillograph. A quartz strip with metal faces contracts longitudinally when the faces are oppositely charged, and this movement may be applied directly to an optical lever; or two strips of quartz may be cemented together in piezo-electric opposition so as to give a bending movement like that of the bimetallic strips used in thermostats. The National Physical Laboratory's exhibits included a Ewing flowmeter (Dr. E. Griffiths and Mr. J. H. Awbery), in which water flowing upwards in a tube containing a steel ball keeps the ball at a height which depends on the rate of flow. When the tube is vertical the ball may either rotate steadily or oscillate from side to side of the tube: two markedly different calibrations are applicable to these two alternative states. Mr. J. Guild showed a colorimeter which enables any mixed colour to be plotted on the colour triangle by means of purely qualitative measurements. The colour is matched against a mixture of a pure red of known wave-length from a filter with monochromatic light selected from a spectrum, the intensities being varied as required but not measured. A similar observation is made with a blue instead of a red filter, and the two wave-lengths of the colours selected from the spectrum determine the required co-ordinates. A useful laboratory method for splitting mica was shown by Mr. F. Harrison Glew. Two pieces of adhesive tape are attached to the faces of a mica sheet and pulled apart. This operation starts a split which can be extended with a piece of cardboard, and by repeating the process a sufficient number of times, sheets giving interference colours can be obtained without difficulty

A discourse was delivered each evening during the Exhibition. At the first, on "The Search for Ultra-Microscopic Organisms," by Mr. J. E. Barnard, the attendance was so great that a number of persons were unable to obtain admission, but the speaker's good nature and endurance proved equal to an immediate repetition of the discourse for their benefit. Mr. Barnard explained that the resolution obtainable with a microscope is limited on one hand by the formation of diffraction patterns if the wave-length be too long, and on the other by the opacity of the lens-material if the wave-length be too short. The organisms which are to be photographed have to be grown on a nutritive layer as thin as 0·2μ, in order to avoid opacity, and the wave-length varies from 220$\mu\mu$ upwards, different wave-lengths giving different pictures, owing to differential absorption in the tissues of the object. The microscope combines two lens systems which are appropriate respectively to visible and to ultra-violet radiation, have one quartz lens in common, and are focussed by means of the same mechanism. The latter is calibrated, so that when focussing has been accomplished for visible light of known wave-length, the instrument can at once be set, with the aid of the calibration, for the required ultra-violet illumination. The visible light is used with dark-ground illumination, the ultra-violet with a camera. The organisms of malignant growths are found to be so small that the ratio of their surface tension to their mass is too great to permit of reproduction by central fission, and young individuals make their appearance as a series of thickenings in the cell wall of the parent, which ultimately remain attached thereto only by a spiral filament.

Prof. A. F. C. Pollard's discourse dealt with "The Mechanical Design of Instruments." He claimed that a scientific instrument must be looked upon as a mechanism, for transmitting motion rather than power, and that it must be designed in strict accordance with kinematic principles. The design of a pair or coupling is governed by the principle that a part is fixed in position when its six possible degrees of freedom have all been constrained by the location of six of its points upon six planes. Any further constraint, such as exists in most instruments, is redundant and involves the accurate fitting together of parts, which is far more difficult and costly than the accurate geometrical shaping of parts taken by themselves: the latter process only is required when redundant constraints are avoided, and at the same time the effects of wear due to imperfect fit are eliminated. The principle was illustrated by reference to actual instruments in which such mechanisms as the hole, slot, and plane of Lord Kelvin and the rectangular knife-edge arrangement of Sir Horace Darwin have been employed. As regards the links or rigid parts of an instrument, their design must be governed by a knowledge of what is practicable in a workshop: for example, castings must not have thin parts integral with adjacent thick parts, and holes must not be located so that in drilling them the tool has to work through a face to which it is inclined.

The discourse by Major W. S. Tucker on "Electrical Listening" was illustrated by a number of demonstrations of the properties of microphones, particularly of the tuned microphones associated with his name and used in military sound-ranging. These instruments, in which a very fine hot wire forming one arm of a Wheatstone bridge is arranged as a mesh across the mouth of a Helmholtz resonator, have been given a much enhanced selective sensibility for low frequency disturbances by closely coupling the main resonator with a second resonator of equal pitch. Perhaps the most striking experiment was that in which the speed of a siren was gradually decreased. The resonant microphone in combination with a vibration galvanometer gave a strongly marked indication as each harmonic of the siren passed through the selected pitch. The speaker also showed records of the notes emitted by lightships, taken at a distance of 9 miles, and of thunderclaps, the indicated duration of the latter being much longer than the duration apparent to the ear.

The trade exhibits included a large number of beautiful instruments, many of them new or improved, but space is available for the description of only very few of these. A fuller account has been published in the illustrated catalogue of the Exhibition The attractive exhibit of Messrs. Adam Hilger, Ltd., included a demonstration with one of their piezo-electric resonators, which are used in standardising wireless wave-lengths. The crystal employed has a mechanical resonance frequency comparable with wireless frequencies, and when it is connected in a suitable circuit, the marked oscillatory piezo-electric E.M.F. which is set up at the fundamental and harmonics of the mechanical resonance enables it to be used for standardising wave-meters, the minimum wave-length being 20 metres. The most interesting feature of the stand occupied by the Cambridge Instrument Co., Ltd., was an improved design of Duddell oscillograph. This instrument is now fully portable, gives direct vision and three simultaneous records on 50 cm. or shorter strips of ordinary photographic paper, permits of any combination of electromagnetic and electrostatic vibrators, and employs a filament lamp. A novelty in dial recorders is the use of carbon paper by the Foster Instrument Co., the stylus making its impression from behind so as to press the carbon paper upon the semi-transparent record paper against the glass face of the instrument. A new method for preventing the bursting, under excess pressures, of the expanding metal chambers used in barometers and the like is embodied in a thermostat by Negretti and Zambra: in this case the chamber is enclosed in a gas-tight chest and the pressure acts upon it from without. Several ingenious features are also to be found in the Ashdown rotoscope (Elliott Brothers (London), Ltd.) for observing periodic movements such as those of machine parts or even of a flying insect. The stroboscopic shutter is a rotating disc driven by clockwork through a five-speed gear, intermediate speeds being adjusted by means of a governor control. The total range of speeds is from 300 to 20,000 r.p.m. The motor can be started or stopped by turning or holding its shaft with the hand, the difference between static and dynamic friction being utilised to this end in the design; the instrument can be held in one hand when in use.

Much interest was shown in a working example of the Admiralty's apparatus for sounding depths by timing echoes, which is being manufactured by Messrs. Henry Hughes and Son, Ltd. The principle employed is that in which a signal note is emitted at regular intervals and a normally deaf telephone is momentarily rendered sensitive after the lapse of an adjustable interval. The length of this interval when the adjustment is such that the echo can be caught by the telephone measures the depth of the sea. It is believed that the use of a rapidly damped signal note, in combination with other detail improvements, has yielded a fool-proof apparatus. Messrs. C. F. Casella and Co., Ltd., exhibited a surveying instrument designed by Dr. J. S. Owens, for recording the inclination of a bore hole in elevation and azimuth. The instrument contains a complete photographic chronograph, a magnetic compass mounted in gimbals, and a clinometer, and it can be inserted complete into a 2-inch bore hole. It should serve to prevent the distress felt by engineers when a borer, after much apparently successful labour, is found to have behaved like a boomerang. Telephones for the relief of deaf persons have been in use for a long time, but have often proved unsatisfactory owing to the variety in types of deafness. To overcome this difficulty Mr. W. H. Pettifor has designed a test instrument which enables prescriptions to be written for individual patients, analogous to opticians' prescriptions; it is found that each patient requires a combination of microphone and telephone having a particular frequency-characteristic and sensitivity.

In all, some seventy-two firms exhibited It is, naturally, impossible in the space available in NATURE to describe more than a few of the many important instruments which went to make up this impressive display.

Regional Scientific Work.

THOSE interested in the publications of the local scientific societies in Great Britain will have noticed that after the falling off in the printing of memoirs which occurred during the War, there has been a healthy revival. Notwithstanding the enormous increase in the cost of printing and binding, many of the scientific societies have reached the pre-Wa standard of their reports, and in some cases have even exceeded that. A perusal of the enormou number of reports and transactions recently issued shows that much more discrimination is now being taken in the publication of papers by the scientific societies. Whether as a result of the Conference of Delegates at the British Association, or the various criticisms and suggestions appearing in NATURE and other journals, those responsible for the production of publications of local interest are certainly adding considerably to the value of these transactions by confining the contents as near as possible to the district covered by the societies' activities.

Some societies are sufficiently strong financially, and in scientific workers, to continue printing their publications independently; others, wisely, have amalgamated, and by thorough organisation have produced a joint publication containing the reports of the various committees and sections, which is of permanent value. As an example of the former, we have recently received the *Proceedings and Transactions of the Croydon Natural History and Scientific Society* (Vol 9, Part 4. Price 5*s*. net). This covers the period February 1923 to January 1925 It includes reprints of the various monthly circulars which the Society has issued containing particulars of the meetings and excursions, with summaries of the work of the sections of archæology, botany, geology, microscopy, physics and chemistry, regional survey, and sociology and psychology. There are the two presidential addresses of Mr. G. M. Davies, one dealing with geology and lines of transport in the Croydon district, and the other with the sea in Surrey, both being of particular value to Croydon naturalists.

An exceedingly valuable part of the publication is that devoted to the meteorological reports for 1923 and 1924, by Mr. F. Campbell Bayard. The cost of compiling and printing these, both from the point of view of time and money, must have been tremendous, and we are not surprised to learn from the Council's report that for both reasons the printing of these reports will not be continued, though full particulars will be sent to the British Rainfall Organisation. Mr. Campbell Bayard is to be congratulated on having accomplished this onerous work for thirty-seven years, and the Society has done well to elect him an honorary member. As a frontispiece to the volume is a really beautiful protrait of the late Mr. William Whitaker, who was one of the most familiar figures at the meetings of many scientific societies, and took a prominent part in Croydon affairs.

The *South-Eastern Naturalist* comes under the second category, and this Society and its organisation is founded upon that of the Yorkshire Naturalists' Union, the pioneer scientific union in the British Islands The South-Eastern Union's publication, the *South-Eastern Naturalist* for 1925 (lxxxii + 107 pp. Price 5*s*. net), contains a record of the Folkestone congress. As frontispiece is the inevitable "group," which always impresses us as containing portraits of a greater proportion of old people than can be found in any other group of this character! Here the reports and proceedings of the various sections and committees, records of the congress, the obituary notices, etc., are thoroughly well done. The presidential address of Sir John Russell, entitled "The Place of Science in Rural Life," is printed. E. C. Stuart Baker refers to evolution and field naturalists; A Steven Corbet writes on the marsh-warbler in Britain, with a bibliography; D. Ward Cutler describes life in a garden soil, Prof. A G. Tansley writes on vegetation of the southern English Chalk; Miss Lillian Lyle on seaweeds of Folkestone—how they grow; A. L. Leach on geological elements in the scenery of south-eastern England (with many interesting illustrations); C. J. Gilbert on the genesis of the Straits of Dover and the creation of Romney Marsh; G. L. Pepler on regional survey as a preliminary to town planning; E A. Robins and J. H. Pledge on making photographic prints for regional survey; E. A. Martin on problems in anthropology; A. H. Reade on Barfrestone Church; and A G. Davies on notes on new geological sections in the London district.

In his paper on problems in anthropology, Mr. Martin says: "When we find what looks like an implement and we do not quite know what were its uses, we say it was some kind of scraper. Scrapers were of all ages in human times. Eoliths would make good scrapers Has any one ever seen a dog or cat take a stone to scrape himself with it? Here again is evidence of the growth of self-consciousness, when man wished to lead a cleanly life. I take it that he did not use his scrapers only for cleaning the skins of animals he had captured and which he wished to utilise as clothing. He would use them to clean himself," and so on.

T. S

Annual Meeting of the Science Masters' Association.

THE twenty-sixth annual meeting of the Science Masters' Association was held on January 5, 6, and 7 at the Household and Social Science Department of King's College for Women, by kind permission of the authorities. There was a large attendance, and the meeting was in every way very successful. After the opening dinner in the refectory of the College, the presidential address was delivered by the Bishop of Birmingham, the Right Rev. Dr. C. W. Barnes.

Dr. Barnes directed attention to the effect of the progress of science upon religious belief, and said that science is now, and must continue to be, an essential element in human culture. It not only gives us a picture of the universe, in which all man's spiritual faculties must find a place, but also helps us the better to understand ourselves and our fellow men. It will, in due course, enable mankind to strengthen its social fabric, to which end it is desirable to check the multiplication of degenerate racial stock. The principles of science and scientific method must be applied universally, even to the phenomena of the religious consciousness. True religion will not suffer if the scientific temper prevails. The absurd contention that if man were a developed ape there could be nothing in him but what the ape possessed is almost forgotten. Using Lloyd Morgan's phrase, Dr. Barnes pointed out that evolution is characterised by the "emergence" of new degrees of reality. Science, he said, can help human progress by destroying false realisations of religious experience and can purify religion by divesting it of accretions which linger from pre-scientific times. It has already banished fear from the minds of educated men by giving them a satisfactory understanding of natural phenomena. It has also banished the gods; the universe is a unity and not subject to the control of super-personalities. Science is built on the postulate of the uniformity of Nature, and its triumphs show that this postulate is sound.

Science has banished the gods: has it banished God? Dr. Barnes is of opinion that, in effect, it has done this if pantheism or naturalism are the interpretation of the universe to which it leads; but no such interpretation is necessary or even probable. That the universe is a self-acting machine is an incredible assumption, and renders the emergence of man's spiritual faculties entirely inexplicable. If, on the other hand, we identify God with the universe, good and evil are alike divine, our moral intuitions are meaningless. Goodness, beauty, and truth must of necessity find a place in our interpretation of the universe, so naturalism and pantheism do not adequately explain the cosmos to which man belongs. Science, then, does not banish God, neither does it banish the conception of the kingdom of God as formulated by the Founder of Christianity. Science, however, can answer none of the ultimate questions. They are not her province. But though her range is limited, within that range she leads us from error to truth, from fantasy to fact. On the truth which science has revealed and is still revealing we have built the new humanism of this age. The religious outlook, in which modern science has been cradled, will not only be able to co-exist with the new humanism, but will derive from it an added power of appeal to the intellect of man.

A vote of thanks to the president was ably moved by a very old and valued friend of the Association, Prof. A. Smithells, and was seconded in a felicitous speech by Prof. Percy Nunn, it was carried with acclamation.

Thursday's programme included a lecture by Prof. Leonard Hill upon "Sunshine, Open Air, and Health," and a discussion upon laboratory assistants, laboratory management, and school exhibitions. On the question of laboratory assistants in schools, a matter which affects most members of the Association very closely, it is felt that some definite scheme for the provision, training, and payment of such men is urgently required, and the committee was requested to make a special inquiry into the subject.

At the business meeting, the momentous decision was taken to institute the formation of local branches. The reasons which led the Association to undertake this step were chiefly two: (*a*) to get into closer contact with local universities, in order to deal more easily with the numerous problems which arise in the teaching of science in schools and in the correlation of school courses with university requirements, etc.; and (*b*) to promote the social side of the Association. Arguments against the formation of branches were put forward, but the weight of the meeting was strongly in favour of the idea. We are pleased to note that according to the rules drafted for the regulation of branches, non-members who are interested in the objects of the Association may, at the discretion of any branch committee, be invited as guests to meetings of the branch other than a business meeting. This affords opportunity for closer co-operation between the Science Masters' Association and the Association of Women Science Teachers, which, in view of the fact that both associations have the same aims and are faced by the same, or very similar, problems, seems very desirable.

Additional features of the meeting were lectures and demonstrations by Prof. B. J. Collingwood, Dr. C. S. Myers, Rev. F. Aveling, Miss W. Spielman and others, while visits were arranged to the National Physical Laboratory and the General Electric Company's Laboratories. There was also an excellent exhibition of scientific apparatus, and of chemicals, by the leading manufacturing firms, while the publishers' show in the Library was a source of great interest, judging from the crowds of members always present there. The table reserved for books written by members of the Association was striking testimony to the literary activity of science masters, and the members' exhibits of apparatus bore witness to no little ingenuity. It is not too much to say that, of all the numerous associations of teachers in Great Britain, the Science Masters' Association is one of the keenest and most vigorous.

The meeting in January 1927 is to be held at Oxford, an announcement which was received with enthusiasm by the members, who retain a lively recollection of the success of the last meeting there. The new president is Brig.-Gen. Harold Hartley, and the chairman for 1926 Mr. E. J. Holmyard (Clifton College).

University and Educational Intelligence.

PROVISIONAL announcements are now available of a number of free public lectures and short courses by eminent men of science and other scholars, to be given at various colleges of the University of London. Lectures at King's College include three by Prof. A. S. Eddington on the constitution and evolution of the stars, commencing February 22; two by Prof. R. Ruggles Gates on vegetation on the Amazon, commencing February 19; and five by Dr. F. A. P. Aveling on the human will, commencing January 18. At University College, Prof. W. H. Lang is to deliver three lectures on the morphology of the Vascular Cryptogams, commencing March 1, at 5.15 P.M.; Dr. C. M. Ariens Kappers, four on the evolution of the nervous system, commencing March 9; Mr. M. H. Krishna, eight on Indian archæology and anthropology, commencing January 18; Miss M. A. Murray, two on Egyptian architecture and primitive cults in ancient Egypt, commencing January 26, Dr. R. W. Lunt, six on the chemistry of ionisation by collision, commencing February 1; Dr. E. G. Richardson, three on the acoustics of buildings, commencing January 19; and Dr. Geoffrey Martin, one lecture on the theory of fine grinding, on February 12, at 5 P.M. Lectures at the London School of Economics include one by Dr. B. Malinowski on the aims of social anthropology, on February 18, at 5 P.M. Except where otherwise stated, the lectures begin at 5.30 P.M.

ALL universities in Ecuador were closed by a Government decree last August. Commenting on this event, the secretary to the United States Legation, Quito, remarks in an article published in the November issue of *School Life*, that for many years past the degrees of doctor of law and doctor of medicine have been too easy of attainment. To graduate in one of these faculties had come to be looked upon as the best badge of "respectability," and the country is flooded with doctors and lawyers, most of whom are unable to earn a living at their profession, and many of whom are but poorly equipped for it. Similar drastic methods of restricting the recruitment for the legal profession have been adopted in Bolivia, where, however, those who have actually begun their professional courses of study are to be permitted to complete them, after which the law faculties are to be closed down. The editor of *School Life* asks whether it is not time to apply some restriction to the present scale of output of lawyers in the United States, where students of law are more than twice as numerous as students of medicine. Only 46 of the 160 law schools require for the law degree so much as five years of study after the completion of the secondary school course, and only one-fifth of the whole number of law students were in those 46 schools. The other four-fifths were in schools which conferred the degree for four years of study at most. It is suggested that the levelling-up process that has in recent years been applied to medical studies should be now applied to the study of law.

Contemporary Birthdays.

January 15, 1875. Dr. T. G. Longstaff, F.R.G.S.
January 17, 1851. Sir James Cantlie, K.B.E
January 18, 1868. Sir Leonard Rogers, C.I.E., F.R.S.
January 21, 1855. Sir Henry B. Jackson, G.C.B., F.R.S.

Dr. T. G. LONGSTAFF, traveller in many regions, and Himalayan mountaineer, was educated at Eton and Christ Church, Oxford. His medical training was pursued at St Thomas's Hospital, London. We quote the following from his paper, "A Mountaineering Expedition to the Himalaya of Garhwal," read before the Royal Geographical Society in January 1908: "I first visited these mountains on my return journey from Tibet in 1905. With my colleagues we hoped to celebrate the jubilee of the Alpine Club by attempting the ascent of Everest, or at least the exploration of its unknown glaciers. We were peremptorily forbidden by the Home Government to enter Tibet."

Sir JAMES CANTLIE comes of Banffshire stock. Educated at Milne's Institution, Fochabers, he graduated at the University of Aberdeen, and entering Charing Cross Hospital Medical School in 1871, he afterwards became a lecturer there. Successive students did not fail to carry on the cheery pseudonym of "Jimmy." An ardent traveller, he has been practically all over the world. He visited China in 1887, and was, from 1889 to 1896, Dean of the College of Medicine for Chinese. Sir James is a Knight of Grace of the Order of St. John of Jerusalem. He has written much on surgical science and public health, and is widely known as an exponent of methods of physical training and bodily efficiency.

Sir LEONARD ROGERS, Lieut-Col. I.M.S. (retired), was educated at Plymouth College. Entering St. Mary's Hospital Medical School, he became F.R.C.S., 1893, M.D. (Lond.), 1897. Physician and lecturer at the London School of Tropical Medicine, he was, before retirement from the Indian Medical Service, professor of pathology at Calcutta Medical College, and Government Bacteriologist. Sir Leonard is a Fothergillian gold medallist of the Medical Society of London, and has received the Mary Kingsley medal of the African Society for researches in tropical medicine.

Admiral of the Fleet Sir HENRY B. JACKSON, Grand Officer of the Legion of Honour, was born at Barnsley. Entering the Navy in 1868, he attained his captaincy in 1896, was controller of the Navy, 1905–8, and commanded the Sixth Cruiser Squadron, Mediterranean, 1908–10. Identified with the initial practical use of Hertzian waves for wireless communication between H.M. ships, it may be recalled that on May 15, 1902, Capt. Jackson read a paper before the Royal Society entitled "On some Phenomena affecting the Transmission of Electric Waves over the Surface of the Sea." He stated that in 1895 he began systematic experiments with the view of utilising the effect of Hertzian waves on imperfect electrical contacts for naval signalling purposes. It is interesting to note that on June 12 following, Mr. Marconi also read two papers, one, "Note on a Magnetic Detector of Electric Waves which can be employed as a Receiver for Space Telegraphy"; the other, "On the Effect of Daylight upon the Propagation of Electromagnetic Impulses over Long Distances."

Early Science at Oxford.

January 18, 1683–4. After the reading of ye Minutes, a letter from Mr. Aston to Dr. Plot, was read; which tells us, that some of ye Royall Society are of opinion, that ye Porphyry Pillars, mentioned in an abstract of Mr. John Greaves MS. (lately communicated to us by Dr. Smith, and transmitted to ye Royall Society) were not brought from Mount Sina, as Mr. Greaves supposes, but dug in Ægypt; wherefore it was ordered, that Dr. Huntingdon should be consulted, as to this matter.

A letter from Dr Hatly of Maidstone concerning some Petrifications found in Kent, was read; He endeavors to prove, that these Petrifications are *Lapides sui generis*, and not made in *animal molds*.

The Ore of ye *Ferrum Noricum** (part of that generous present, with which ye learned Martin Lister Esq has lately oblidged our University) was seen to apply to ye magnet; as also ye common black writeing sand; neither of which can well be supposed to have undergone ye fire. It was then quæried, whether our common ores will not apply, if powdered? Dr. Plot was pleased to take on him ye trouble of trying it.

1686–7. A letter from Mr. Peck of Mayfeild in Sussex, was read. It gave a large account of the man sick of a Feaver mentioned in the Minutes of Dec. the 7th. with some other cases in Physic very remarkable. Mr. President's letter to Mr. Halley concerning the cause of the Trade-winds, was read.

January 19, 1685–6. A letter from Mr. Molyneux, concerning some observations on Mr. Hevelius's *Annus Climactericus* and on his account of ye Lunar Ecclipse on ye 30th of Nov: 1685—A letter from Mr. Brown to Mr Aston concerning ye Liver as appearing glandulose in a morbid body opened at St. Thomas's Hospitall, London; A letter, subscribed W. Tenon, concerning Dr. Papin's way of raising water, were all communicated and read.

January 20, 1684–5. A foot cubic measure, made by order of ye Society was presented by Mr. Caswell, and Mr. Walker. A catalogue of experiments to be tried with this measure, was drawn up, and put into Mr. Caswel's hands; and a pair of fine scales were proposed to be provided.

A letter from Dr. Middleton, Provost of Kings College, Aberdeen, gives us hopes, of what we have so long, and so earnestly desired, viz a correspondence with Scotland. The Doctor desiring some account of ye manner of our proceedings, ye Secretary is commanded to prepare a transcript of ye Orders, and ye latest Minutes, to be sent him.

A detailed Answer was given to ye 39th Quere of Sir William Petty's Catalogue of Experiments to be tried, (which Q. runs thus, viz: How many shoes of a certain size, a shoemaker can make up in a time given?). It was Affirmed that of ye five first sizes of *children's shoes*, called *Children's pumps*, 12 pair may be made, by a good workman, in one day; that of children's *Eights*, 4 pair are an ordinary days work; and that of Women or Men's *Sixes*, 3 shoes, or 2 pair, are usually a Day's work.

Mr. Musgrave affirmed that 80 lb: of Wedgbury pit coal, kindled at several times, with 4¼ lb of Charcoal, gave a little above ¼ of a peck of Ashes, which weighed 4¼ lb. avoird', beside which about a pound of coal was left unburnt in ye grate: so that a pound of this sort of coal, well burnt, does not yeild an ounce of Ashes. A discourse was presented by Mr. Walker, proving from experiment, that ye longer ye wheels of a coach are, (cæteris paribus) ye more easily they may be drawn over a stone, or such like obstacle, that lies in ye way.

Societies and Academies.

LONDON.

Optical Society, December 10.—Col. H. S. L. **Winterbotham**: General principles of photographic surveying. A brief outline is given of the development of photogrammetry from terrestrial and aerial positions, and an indication of some of the points to be considered in the design of instruments required by the photogrammetric surveyor in Britain.—Lieut.-Col. W. N **MacLeod**: Perspective conditions of photogrammetry. The perspective conditions which must be satisfied in aerial survey work are discussed and the methods of reconstructing these conditions from the photographs obtained are described. Attention is directed to the desirability of designing new apparatus, with which to carry out the necessary reconstruction with the requisite accuracy.—Lieut. M. **Hotine**: Some precision problems in air survey. The various factors upon which accuracy in air survey measurements depends are described and suggestions are made as to some of the conditions which should be fulfilled in apparatus employed for such measurements.

The Physical Society, December 11.—E. A. **Owen** and G. D. **Preston**: The effect of rolling on the crystal structure of aluminium. Sheets of aluminium have been examined by the ionisation spectrometer and by photographic methods. When a cast specimen of aluminium containing a number of large crystals oriented at random throughout the body of the material is rolled, the crystals break up into a large number of minute crystals. As the thickness of the material is progressively diminished, the small crystals tend to take up a definite orientation, each crystal having a cube diagonal in the direction of rolling and a (211) plane in the plane of rolling. Two sets of crystals exist in the material after rolling, one set being the optical image of the other in the plane of rolling. The ionisation spectrometer indicates that the type of the space lattice remains unaltered, and that the parameter of the material in the severely worked condition does not differ from that of the annealed material by more than 0·5 per cent.—R. S. **Burdon**: The spreading of one liquid on the surface of another. Purest "conductivity" water in the presence of air spreads very slowly on a clean mercury surface; the spreading is greatly accelerated by traces of acid in solution, and totally inhibited by traces of alkali. All the neutral salts tested, even chlorides of mercury and silver, produce rapid spreading. The concentration of the solution controls the rate of spreading. All acid solutions tested spread rapidly, probably reacting chemically with the mercury. One part of hydrochloric acid in ten million of water definitely accelerates spreading. A drop of very dilute acid spreads rapidly to cover a definite area and stops, any further spreading being as slow as that of water. The area covered during the rapid stage is proportional to the number of acid molecules present, and is larger than would be expected if a monomolecular layer of the appropriate salt were formed on the mercury surface. Electrostatic fields up to 4,000 volts/cm. applied perpendicular to the surface produce no visible results. Placing a platinum wire from one terminal of a battery in the mercury and from the other terminal in the drop, and applying small voltages, causes spreading even in alkalis if the mercury be positive, and prevents spreading even in dilute acids if the mercury be negative. Photographs show that the spreading drop is preceded by a well-defined ridge.—J. T. **Combridge**: On the advance of the perihelion of mercury. Attention is directed to the infinite possibilities of obtaining the Einstein equation for the orbit of a planet by using Newtonian mechanics with an extended potential function. Observational tests being equally satisfied, Einstein's theory is to be preferred on account of its extensive unity and the spontaneity of its results.

Linnean Society, January 7.—Eric Marsden **Jones**: On the fertilisation of *Primula vulgaris* Huds. Observations were made by day and night in a wood at Potterne in Wiltshire in order to ascertain with the greatest degree of accuracy the part that day- and night-flying insects might play in the pollination of this plant. During day observations, five important species of insects were seen pollinating frequently. During night observations the only visitors seen were *Meligethes erythropus*, *Tachyporus salutus*, and *Forficula auricularia*, which are of no value from a pollinating point of view. Two blocks of 50 plants each were covered alternately day and night as a control. The patch from which insects were excluded at night produced 343 capsules, while the one exposed by night, and from which day-flying insects were excluded, produced only 5, for which there is an explanation. Six plants covered entirely day and night were absolutely sterile. It seems, therefore, that diurnal insects pollinate efficiently, and that nocturnal Lepidoptera play no part whatever in the pollination of *Primula vulgaris*.—M. A. C. **Hinton**: Persistent growth in the water vole and old age in the wart hog. A contribution to the growth and death discussion. The ancestors of the voles possessed tuberculate teeth of limited growth adapted for bruising and crushing the relatively soft and succulent substances composing a mixed diet. The voles have acquired the power of subsisting upon coarse, tough, vegetable substances, and this has led to modifications, particularly in the molar teeth. These have become tall-crowned, prismatic structures adapted for slicing and shearing the food; and the dentinal pulps and enamel organs of the teeth appear to remain active throughout life. The water vole (*Arvicola amphibius*) is remarkable in another way: In the oldest individual known, not only were the molar teeth actively growing at the moment of death but the skeletal development was still incomplete It would seem that the water vole and some of its relations never stop growing. The last molar and the enormous canines of the wart hog have been described as being persistently growing teeth. Recently acquired material shows that, if the wart hog lives long enough, these teeth finish growing, develop roots, and wear out, so that in due course the animal becomes senile and dies. Probably if we could secretly defend a water vole from accident indefinitely while exposing it to normal Microtine existence, its growth would cease, and it would proceed to old age and death like a normal mammal.

SYDNEY.

Linnean Society of New South Wales, November 25.—A. **Philpott**: The labial palpi of *Trichophysetis cretacea* and *Argyria amoenalis*. Modifications of the palpi occur in males although the females are quite normal.—John **Mitchell**: Descriptions of new species of Leaia. The genus is confined to rocks of Carboniferous and Permian ages; and consequently its occurrence, in great variety, in the Newcastle Coal Measures forms one of the most convincing proofs of the Permian age of these measures. Thirteen species are described as new.—H. M. **Hale**: The development of two Australian sponge-crabs. Two marine crabs, an oxyrhynch (*Paranaxia serpulifer*) and a dromiid (*Petalomera lateralis*), do not pass through the usual free-swimming larval stages, the young leaving the female in the adult form. In the latter, at least two advanced juvenile stages are spent in the brood-pouch of the female. The metamorphosis is almost completely suppressed in another sponge-crab (*Cryptodromia octodentata*) and a third (*Platydromia thomsoni*) probably has a "direct" development.—Ida A. **Brown**: Geology of the Milton District. Within a radius of ten miles of Milton there are a number of outcrops of igneous rocks. An account is given of the albitisation and of the history of the intrusions.—I. M. **Mackerras**: The Nemestrinidæ (Diptera) of the Australasian region. Of the 40 specific names hitherto proposed, 22 are considered as valid and 2 cannot be placed; 1 genus, 16 species, 3 subspecies and 1 variety are described as new.—E. W. **Ferguson**: Description of a new species of Mycetophilidæ (Diptera) with luminous larvæ. A new species of Arachnocampa is described from Ida Bay Caves, Tasmania.—L. **Harrison** and Hazel C. **Weekes**: On the occurrence of placentation in the scincid lizard, *Lygosoma entrecasteauxi*. The occurrence of true placentation in two not very closely related scincid lizards, Lygosoma and Chalcides, in Australia and Europe respectively, indicates that the allantoplacenta is a functional adaptation which may have arisen independently many times in evolution, and upon the mere occurrence of which phylogenetic statements cannot justifiably be based. A consideration of reptilian placentation suggests three stages, chorioplacenta, omphaloplacenta and allantoplacenta arising in that serial order, both in ontogeny and phylogeny.—W. J. **Phillipps** and F. J. T. **Grigg**: The salinity of inshore oceanic waters of Australasia in relation to fishes.

Official Publications Received.

The Indian Forest Records, Vol. 11, Part 10 (Economy Series). Notes on the Antiseptic Treatment of Assam Timbers for Railway Sleepers. By J. H. Warr, assisted by S. Kamesam. Pp. iv+106. (Calcutta: Government of India Central Publication Branch.) 1.14 rupees, 2s. 3d.

Meteorological Office: Air Ministry. Advisory Committee on Atmospheric Pollution: Report on Observations in the Year ending March 31st, 1925. Forming the Eleventh Report of the Committee for the Investigation of Atmospheric Pollution. (M.O. 280.) Pp. 46. (London: H.M. Stationery Office.) 5s. 6d. net.

Madras Fisheries Department. The Fishing Methods of the Madras Presidency. By James Hornell. Part 1: The Coromandel Coast. (Report No. 2 of 1924, Madras Fisheries Bulletin, Vol. 18.) Pp. 59-110. (Madras: Government Press.) 12 annas.

Society for the Provision of Birth Control Clinics. Annual Report 1924–1925. Pp. 14. (London: 153a East Street, S.E.17.)

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30th, 1925. (New Series 14.) Edited by Prof. Alexander Meek. Pp. 58. (Cullercoats.)

Leeds University. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing, during the Session 1924–25. Pp 16. (Leeds.)

University of California Publications in American Archaeology and Ethnology. Vol. 17, No. 7: Archaic Culture Horizons in the Valley of Mexico. By A. L. Kroeber. Pp 373-408+1 plate. (Berkeley, Calif.: University of California Press.) 45 cents.

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 24, Part 7: The North American Species of Stipa; Synopsis of the South American Species of Stipa. By A. S. Hitchcock. Pp. xi+215-289. (Washington: Government Printing Office.) 15 cents.

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 17: Professional Staff of State Departments of Education. By Arthur Wesley Ferguson. Pp. iv+64. (Washington: Government Printing Office.) 10 cents.

The Physical Society of London. Proceedings, Vol. 38, Part 1, December 15. Pp. 92. (London: Fleetway Press, Ltd.) 6s. net.

Transactions of the Royal Scottish Arboricultural Society. Vol. 39, Part 2, October. Pp. 89-218+31-39. (Edinburgh.) 5s.

Bernice P. Bishop Museum. Bulletin 15: Samoan House Building, Cooking and Tattooing. By E. S. Craighill Handy and Willowdean Chatterson Handy. Pp. 26+7 plates. Bulletin 16: Juan Fernandez and Hawaii, a Phytogeographical Discussion. By C. Skottsberg. Pp. 47. Bulletin 17: Music in the Marquesas Islands. By E. S. Craighill Handy and Jane Lathrop Winne. Pp 51. Bulletin 18: String Figures from the Marquesas and Society Islands. By Willowdean Chatterson Handy. Pp. 92+4 plates. Bulletin 19: Hawaiian Fungi. By Frank Lincoln Stevens. Pp. 189+10 plates. Bulletin 20: Tropical Cyclones of the Pacific. By Stephen Sargent Visher. Pp. 163. Bulletin 21: Report of the Director for 1924. By Herbert E. Gregory. Pp. 55. Bulletin 22: Fishes of Guam, Hawaii, Samoa and Tahiti. By Henry W. Fowler. Pp. 38. Bulletin 23: Archaeology of the Marquesas Islands. By Ralph Linton. (Bayard Dominick Expedition, Publication No. 10.) Pp. 187+15 plates. (Honolulu, Hawaii.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Vincent, for the Year 1924. Pp. iv+46. (Trinidad.) 6d.

National Museum of Wales. Eighteenth Annual Report, 1924–25, presented by the Council to the Court of Governors on the 23rd October 1925. Pp 42+7 plates. (Cardiff.)

Diary of Societies and Public Lectures.

SATURDAY, January 16.

Scottish Junior Gas Association (at Royal Technical College, Glasgow), at 7.—D. Garrie: Paper.

MONDAY, January 18.

Royal Geographical Society (at Lowther Lodge), at 5.—The New Photo-Theodolite of Mr. A. Wild (Report and Discussion).

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Fossil Remains of Ape and Man: (1) The Anatomical Characters of the Galilee Skull.

Faraday Society (at Chemical Society), at 5.30.—B. B. Banerji: The Electrode Capacity and Resistance of Electrolytes for a Wide Range of Frequencies.—J. A. V. Butler, W. E. Hugh, and D. H. Hey: The Effect of the Electrode Material on Oxidation Potentials.—R. H. W. Maddison: The Electromotive Behaviour of Cupric Oxide.—A. Highfield: The Colloidal Properties of Nitrocellulose Sols in Mixed Solvents.—E. P. Perman and T. Lovett: Vapour Pressure and Heat of Dilution of Aqueous Solutions. Part I. (*a*) Vapour Pressure of Aqueous Solutions of Urea; (*b*) Heat of Dilution of Aqueous Solutions of Urea.—W. Taylor: A Note on Kinetic Activation as a Factor in Gas Reactions.

Institution of Automobile Engineers (Loughborough Graduates' Meeting) (at the College, Loughborough), at 7.—C. Legge: Sparking Plugs.

Institution of Electrical Engineers (Teesside Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.15.—E. E. Dunn, W. S. Ramsdale, and others: Informal Discussion on The Isolation, Location, and Repairs of Faults.

Junior Institution of Engineers (North-Western Section) (at 16 St. Mary's Parsonage, Manchester), at 7.15.—W. D. Adamson: The Importance of the Selling Aspect of Production Planning.

Institution of Automobile Engineers (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—J. D. Parkes: Logic applied to Failures.

Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.30.—A. P. Trotter: Illumination and Light (Faraday Lecture).

Royal Institute of British Architects, at 8.—Award of Prizes and Studentships.

Royal Society of Arts, at 8.—H. P. Shapland: The Decoration of Furniture (Cantor Lectures) (1).

Aristotelian Society (at University of London Club), at 8.—Dr. F. W. Thomas: Conventional Existence.

Chemical Industry Club.

Institute of Chemistry (Manchester and District Section) (at Manchester).—C. Hollins and others: Discussion: Chemical Nomenclature.

TUESDAY, January 19.

Royal Anthropological Institute (Edinburgh and the Lothians Branch) (at Synod Hall, Edinburgh), at 5.—Dr. J. Ritchie: The Arrival of Man in Scotland.

Royal Institution of Great Britain, at 5.15.—Prof. J. A. Crowther: X-rays and Living Matter (1).

Royal Statistical Society (at Royal Society of Arts), at 5.15.—R. J. Thompson: The Productivity of British and Danish Farming.

Royal Society of Medicine, at 5.30.—General Meeting.

Mineralogical Society (at Geological Society), at 5.30.—Dr. C. E. Tilley: Some Mineralogical Transformations in Crystalline Schists.—Dr. A. Brammall: Gold and Silver in the Dartmoor Granite.—A. H. Hallimond: On the Chemical Classification of the Mica Group. II. The Basic Micas.—G. Greenwood: The Construction and Use of an X-ray Goniometer.

Institute of Marine Engineers, at 6.30.—W. Blane: Poetry and the Engineer.

Institution of Electrical Engineers (East Midland Sub-Centre) (at Loughborough College), at 6.45.—A. B. Mallison: Justifiable Small Power Plants.

Royal Photographic Society of Great Britain (Scientific and Technical Group), at 7.—W. D. Baldsiefen, F. F. Renwick, and Dr. V. B. Sease: Silver Iodide in Photographic Emulsions.

Institution of Automobile Engineers (Coventry Graduates' Meeting) (at Coventry), at 7.15.—H. W. Sisman: The Straight Eight Engine.

Society of Chemical Industry (Birmingham and Midland Section) (at Birmingham University), at 7.15.—B. D. Porritt: Early Days of the Rubber Industry.

Institution of Automobile Engineers (Wolverhampton Centre) (at Wolverhampton), at 7.30.—H. Briggs: The Elimination of Noise in the Motor Cycle.

Institution of Electrical Engineers (North-Western Centre) (at College of Technology, Manchester), at 7.30.—A. P. Trotter: Illumination and Light (Faraday Lecture).

Institute of Metals (North-East Coast Local Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.—Prof. F. C. Thompson: The Principles which Govern the Heat Treatment of Non-Ferrous Alloys.

North-East Coast Institution of Engineers and Shipbuilders (Middlesbrough Branch) (at Cleveland Scientific and Technical Institute, Middlesbrough), at 7.30.—S. E. Burgess: Public Works and Housing at Middlesbrough.

Royal Anthropological Institute (Indian Section), at 8.15.—Discussion on Periods in Indian History.

British Institute of Philosophical Studies (at Royal Society of Arts), at 8.15.—A. D. Lindsay: The Theory of Sovereignty and the League of Nations.

WEDNESDAY, January 20.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Fossil Remains of Ape and Man (2): The Interpretation of Endocranial Casts taken from Skulls—Ancient and Modern.

Geological Society of London, at 5.30.—T. O. Morris and Prof. W. G. Fearnsides: The Stratigraphy and Structure of the Cambrian Slate Belt of Nantlle (Carnarvonshire).

North-East Coast Institution of Engineers and Shipbuilders (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.—F. Hamilton: Locomotive Valve Gears.

Institution of Automobile Engineers (Birmingham Graduates' Meeting) (at Birmingham), at 7.30.—E. W. Sisman: The Straight Eight Engine.

Institution of Electrical Engineers (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—G. H. Nelson, H. W. Walker, D. M. Rait, and D. H. Davies: Regulations (Short Addresses).

Royal Microscopical Society (Annual Meeting), at 7.45.—A. Chaston Chapman: The Fungi Imperfecti, and a Further Plea for an Institute of Industrial Micro-Biology (Presidential Address).

Royal Meteorological Society (Annual General Meeting), at 7.10.—Presentation of the Symons Medal to Lieut.-Col. E. Gold.—C. J. P. Cave: Address on the Work of the Society during the Past Year, followed by an Exhibition of Lantern Slides of Clouds.

Royal Society of Arts, at 8.—Dr. H. H. Morgan: Problems in Paint and Varnish Technology.

C.B.C. Society for Constructive Birth Control and Racial Progress (at Essex Hall, Essex Street), at 8.—L. Jefferson: Religion and Birth Control (to be followed by a discussion).

Entomological Society of London, at 8.—Annual Meeting.

Institution of Structural Engineers, at 8.—Major R. A. B. Smith: Concrete Roads in America, and the Application of their Principles of Design and Construction to Great Britain.

Society of Chemical Industry (Nottingham Section) (at Nottingham).—Dr. Clibbens: Dyeing and Bleaching of Cotton.

Society of Glass Technology (at Manchester).

THURSDAY, January 21.

Royal Society, at 4.30.—W. Barlow: The Configuration of the Carbon Atom and the Geometrical Relations of this Configuration to those of other Atoms as evidenced in the Chemical and Crystallographic Structures of Organic Chemistry. Part I.—R. E. Gibbs: Structure of a Quartz.—H. J. Gough, D. Hanson, and S. J. Wright: The Behaviour of Single Crystals of Aluminium under Static and Repeated Stresses.—C. H. M. Jenkins: The Determination of the Vapour Tensions of Mercury, Cadmium, and Zinc by a Modified Manometric Method.—*To be read in title only*:—Ursula Andrewes, Dr. Ann C. Davies, and Prof. F. Horton: The Soft X-Ray Absorption Limits of Certain Elements.—Prof. W. L. Bragg and G. B. Brown: The Crystalline Structure of Chrysoberyl.—H. G. Telling: On a Set of Quartic Surfaces in Space of Four Dimensions; and a certain Involutory Transformation.—L. F. Richardson: Atmospheric Diffusion shown on a Distance-Neighbour Graph.—T. Alty: Some Phenomena occurring at the Surface of Bubbles in Water.—A. L. M. Sowerby and S. Barratt: The Line Absorption Spectra of the Alkali Metals.—Prof. A. M. Tyndall and G. C. Grindley: The Mobility of Ions in Air, Parts I. and II.—W. Jevons: A Band Spectrum of Tin Monochloride exhibiting Isotope Effects.—J. H. Andrew, M. S. Fisher, and J. M. Robertson: Some Physical Properties of Steel and their Determination.

Linnean Society of London, at 5.—Prof. Fantham and Dr. Annie Porter: Two Protozoan Parasites in the Latex of *Ficus edulis* and *Euphorbia striata*.—Dr. H. Hamshaw Thomas: The Relations of the Caytoniales with the Modern Flowering Plants.

Royal Society of Medicine (Dermatology Section), at 5.—Prof. Levaditi: Les nouvelles découvertes dans la chimio-thérapie de la syphilis.

Royal Institution of Great Britain, at 5.15.—Prof. C. J. Patten: The Language of Birds.

Institution of Mining and Metallurgy (at Geological Society), at 5.30.

Institution of Electrical Engineers, at 6.—J. L. Thompson and H. Walmsley: Notes on the Testing of Static Transformers.

Royal Aeronautical Society, at 6.30.—Major J. S. Buchanan: The Schneider Cup Race, 1925.

Illuminating Engineering Society (at Royal Society of Arts), at 7.—E. Farmer and others: Discussion on The Lighting of Coal Mines.

British Astronomical Association (West of Scotland Branch) (at Royal Technical College, Glasgow), at 7.30.—J. D. M'Dougall: Planetary Orbits.

Optical Society (at Imperial College of Science), at 7.30.—R. Kingslake: The Interferometer Patterns due to the Primary Aberrations.—J. Guild: Demonstration of (a) a Trichromatic Colorimeter suitable for Standardisation Work; (b) a Vector Colorimeter, an Instrument Operating on a New Principle.—The Gaumont Company, Ltd.: (a) The "Trans-Lux" Daylight Picture Screen; (b) An Opaque Projector.

Institution of Automobile Engineers (Luton Graduates' Meeting), at 7.30.—C. H. Gritton: Epicyclic Gearing.

Institution of Automobile Engineers (London Graduates' Meeting), at 7.30.—L. F. Little: The Design of Light Alloy Pistons.

Institution of Electrical Engineers (Irish Centre, Dublin) (at Trinity College, Dublin), at 7.45.—A. P. Trotter: Illumination and Light (Faraday Lecture).

Chemical Society, at 8.—R. G. W. Norrish and G. G. Jones: Studies of Valency. Part VII. Surface Polarity and the Reaction of Ethylene and Chlorine. The Effect of the Adsorbed Water Layer.—W. Charlton, W. N. Haworth, and S. Peat: A Revision of the Structural Formula of Glucose.—Dr. J. G. F. Druce and F. H. Loring: Dvi-manganese.—R. Forsyth, V. K. Nimkar, and F. L. Pyman: The Nitration of Benzamidines.

Royal Society of Tropical Medicine and Hygiene (at 11 Chandos Street, W.), at 8.15.—Dr. Hasson: A New Procedure in the Diagnosis and Treatment of Leprosy.—Lt.-Col. W. P. Macarthur: Old-time Plague in Britain.

Institution of Mechanical Engineers (Manchester Branch), Annual Meeting.

FRIDAY, January 22.

Royal Society of Arts (Indian Section), at 4.30.—Col. W. M. Coldstream: Indian Maps and Surveys.

Physical Society of London (at Imperial College of Science and Technology), at 5.—Prof. T. H. Laby: A Critical Discussion of the Determinations of the Mechanical Equivalent of Heat.—F. L. G. Rawlins: The Present Status of Theory and Experiment relating to Specific Heat and the Chemical Constant.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Fossil Remains of Ape and Man: (3) Ancient Dwellers in the Thames Valley.

Institution of Mechanical Engineers, at 6.—Prof. A. H. Gibson: Piston Temperatures and Heat Flow in High-Speed Petrol Engines.

Society of Chemical Industry (Chemical Engineering Group) (jointly with the Liverpool Section) (at Liverpool University), at 6.—Dr. E. B. Maxted: The Use of High Pressures in Chemical Industry.

Institution of Electrical Engineers (London Students' Section), at 6.15.—C. F. George: Switchgear.

Society of Chemical Industry (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.—B. D. W. Luff: Modern Views on the Vulcanisation of Rubber.

Junior Institution of Engineers, at 7.30.—E. Granville-Smith: The Engineer and his Relationship to the Tea Industry.

Geologists' Association (at University College), at 7.30.—F. Gossling and S. W. Wooldridge: On Outliers of Lenham Beds at Sanderstead, Surrey.—A. G. Davis: Some Chalk Sections in N.E. Surrey.—N. L. Silvester: Glacial Features in a New Exposure at Finchley.—H. W. Cornes: Some Recent Sections in the Glacial Deposits of the Finchley Plateau.

North-East Coast Institution of Engineers and Shipbuilders (at Newcastle-upon-Tyne), at 7.30.—A. Campion: Cast Iron for Internal-Combustion Engines.

North-East Coast Institution of Engineers and Shipbuilders (Middlesbrough Branch, Graduate Section) (at Middlesbrough), at 7.30.—J. Miller: Electric Lifts.

Architectural Craftsmen's Society (at Royal Technical College, Glasgow), at 7.45.—D. L. Crawford: Architecture Past and Present in West Highlands.

Royal Institution of Great Britain, at 9.—Sir William Bragg: The Work of the Davy Faraday Research Laboratory.

Institution of Mechanical Engineers (Sheffield Branch Meeting).—A. V. Kemp: Modern Developments in Open Hearth and other Steel Works Furnaces.

West of Scotland Iron and Steel Institute (at Royal Technical College, Glasgow).—Dr. A. M'Cance: Open Hearth Practice.

SATURDAY, January 23.

Electrical Association for Women (at Æolian Hall), at 3.—Demonstration of the Application of Electricity in the Production of Music for the Home.—H. V. Spanner: The Place of Music in the Home (Lecture).

Royal Institution of Great Britain, at 3.—H. Balfour: The Evolution of Currency and Coinage.

Physiological Society (at National Institute for Medical Research).

PUBLIC LECTURES.

MONDAY, January 18.

University College, at 4.—H. Higgs: Some Social Problems in the Light of Economics and Statistics (Newmarch Lectures). (Succeeding Lectures on January 25, February 1, 8, 15, and 22.)—At 5.30.—M. H. Krishna: Indian Archæology and Anthropology. (Succeeding Lectures on January 25, February 1, 8, 15, 22, 26, and March 1.)

King's College, at 5.30.—Dr. F. A. P. Aveling: The Human Will: Greek Views.

TUESDAY, January 19.

University College, at 5.30.—Dr. E. G. Richardson: Acoustics of Buildings. (Succeeding Lectures on January 26 and February 2.)

WEDNESDAY, January 20.

Institute of Historical Research, at 5.30.—N. B. Jopson: The Earliest Civilisation of the Slavs. (Succeeding Lectures on January 27, February 3, 10, 17, 24.)

University College, at 5.30.—Justice Piggott: Insanity, Legal and Medical.—Prof. G. Elliot Smith and W. J. Perry: The Study of Man. (Succeeding Lectures on January 27, February 3, 10, 17, 24.)

Gresham College (Basinghall Street), at 6.—Sir Robert Armstrong Jones: Physic. (Succeeding Lectures on January 21, 22.)

THURSDAY, January 21.

King's College, at 5.30.—S. Smith: Early Arabian Tribes.

FRIDAY, January 22.

University College, at 4.30.—Prof. C. Spearman: Facts and Fallacies about Mental Tests.

SATURDAY, January 23.

Horniman Museum (Forest Hill), at 3.30.—Miss M. A. Murray: Europe's Debt to the Ancient Egyptians.

SATURDAY, JANUARY 23, 1926.

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Science and Humanism.

IT is sometimes instructive, sometimes amusing, but always interesting "to see ourselves as others see us," even when we think that their view is distorted. To the January issue of the *Nineteenth Century and After*, Mr. G. R. Stirling Taylor contributes an article entitled "The Age of Science," in which he advances criticisms of science and scientific men that are intended to represent the views of the intelligent man in the street. Starting with the assumption that science has dominated the world during the past 100-150 years (he really means the applications of science), he asks whether that domination has been good for man, or whether in harnessing Nature man has not also harnessed himself.

The steam-engine has led to the individual being subordinated to the machine; village life, with its sunshine and fresh air, has been largely replaced by industrial centres, with their slums, their polluted atmosphere, and their noise; and the electric telegraph has caused power to be concentrated in the hands of centralised groups of individuals. In a very real sense the late War was a war conducted by science—by the engineer, the chemist, and the physicist—and for the next war preparations are being made that "may blot out civilisation in a few months at longest." That much good has been done by science, and particularly by medicine, is not denied; but many of the ills that have been cured by it are the result of conditions which science itself has caused. Cold storage has increased our gastronomic temptations and made possible gross profiteering by the holding up of provisions.

Although the man of science may contend that such misapplications of science as chemical warfare are solely the responsibility of those who authorise their practice, the plain man, who cares nought for idealist intentions and is interested only in practical results, will saddle him with the blame: to turn loose a poison gas that may annihilate a city is, in its practical outcome, as immoral as to arm a crowd of drunken savages with knives and revolvers. May not a scientific man with an uncontrolled passion for truth (that is, discovery) be as dangerous as a man who has an unbalanced desire for alcohol?

Mr. Stirling Taylor then institutes a comparison of the man of science with the man of religion. Unlike the former, the priest has never made the amazing blunder of putting material truth in the centre of his altar, and he has never quite forgotten that human welfare is the chief end of life. The laws of both are dogmas, and the plain man will prefer such an unprovable dogma as that there is a God who commands us to do right, to the logically water-tight dogma that a certain chemical procedure will split the atom and blow the world to pieces. "By their fruits ye shall know them," and the real test of the value of science is whether the men who work the machines and live round the factory are the better or the worse for its help and presence. Like the French revolutionists of the Reign of Terror, science has admirable intentions; it is the result which has been so disastrous.

Mr. Stirling Taylor's strictures on the evils accompanying industrial development, due mainly to the applications of science, are not novel; and although they are not entirely without a basis of fact, they certainly lack that very balance which he describes as the secret of life. On the material side he omits a host of directions in which the applications of science have proved beneficial, and he concentrates chiefly on certain unpleasant developments which first became prominent during the War. Throughout his article, he fails to discriminate between the discoverer and the inventor: the man who searches for new things and the man who applies them to human purposes.

In their ethical aspect, human acts can be classified as moral, immoral, or amoral, although the dividing line is not always easy to draw. "A good work of art," said Goethe, "may and will have moral results, but to require of the artist a moral aim is to spoil his work." Whatever view one may take as to the truth of this dictum in the sphere of art, we believe that the first part of it does not apply to science, and that a good piece of scientific work belongs strictly to the amoral category. On the other hand, the latter part of the dictum is certainly applicable: the searcher after truth of all kinds must go forward regardless of consequences, at any rate within the confines of his laboratory or study. The plain man, however, will argue that the social effect of an action cannot be overlooked, even if its morality is determined mainly by the intention behind it; and to this extent we think that Mr. Stirling Taylor is right in stating that a great responsibility falls upon those who discover potential weapons of inhuman warfare; although much greater responsibility must rest with those who use or sanction the use of these weapons. The intelligent man in the street must see that to abandon investigations on lethal weapons while other nations pursue them is to court disaster, if not extinction. However much we may detest these weapons, the calls of home, of country, and of Empire must come first. In these circumstances the responsibility of the scientific workers concerned appears to be confined to the observance of strict secrecy in their work. In almost every other sphere of scientific activity, freedom in publication is essential; but in this case both morality and national security demand that it should be taboo.

The best reply to Mr. Stirling Taylor's article, which deals exclusively with the material applications of science, is supplied by the presidential address, entitled "Science and the New Humanism," which was delivered by the Right Rev. C. W. Barnes, Bishop of Birmingham, to the Science Masters' Association (and will appear in the February issue of the *School Science Review*). In Dr. Barnes' opinion, science has changed the whole background of our thought by giving us a new knowledge of man's origin and place in the universe. Every branch of human thought feels the influence of the new knowledge. The outlook of our grandparents, the postulates of their thinking, have become incredibly remote. Despite certain ills following in the wake of industrial applications, science is ultimately beneficent and not brutal. As an instrument of education, modern science cannot replace what are traditionally called the humane studies; yet knowledge of scientific truth and appreciation of scientific method are indispensable to all, because they are the foundation of modern humanism, and without them human thought would progressively degenerate. Science has practically freed the civilised world from the thraldom of base superstition; it has banished irrational fear; and it has purified religious thought.

The intelligence of civilised man is the outcome of from one to two million years of human and sub-human growth. Not merely do animal instincts and passions survive in us, but the structure of our mind retains traces of an animal past. In times of emotional upset, such as during the War, primitive mental processes assert their vitality; and we go back to the second century of our era to find a parallel to the crazy necromancy, astrology, and magic that flourish to-day. The principle of evolution is now firmly established—as the world's laughter at Tennessee has amply demonstrated. Originally a biological theory, it is now the unifying factor in anthropology, and its influence on psychology is great and growing. Evolutionary psychology and anthropology have given us a more penetrating insight into human civilisation, and in due time they will enable mankind to strengthen his social fabric.

Although science cannot answer ultimate questions concerning matters outside the realm of physical and biological phenomena, it can lead us within that realm from error to truth, from phantasy to fact; and it is on the truth which science has revealed, and is revealing, that we are building the new humanism of our age.

Ideas of God in the Religions of the World.

The Attributes of God: the Gifford Lectures delivered in the University of St. Andrews in the Year 1924–25. By Lewis Richard Farnell. Pp. x+283. (Oxford: Clarendon Press; London: Oxford University Press, 1925.) 12s. 6d. net.

DR. FARNELL'S title is reminiscent of the lofty flights of Scholastic or Puritan divines, but his actual mode of procedure is at once more modest and more modern. It is, in fact, the historical and comparative method which he has already so successfully employed in his "Greece and Babylon" and "The Evolution of Religion." The aim and scope of these lectures, he tells us, is "not so much the problems of the philosophy of religion, but a review of the qualities and activities attributed to God in the religions that are living and have lived," the material for study being the religious literature of the world and to some extent religious art. He therefore proposes to deal "only with the philosophic thought that has borne fruit in real popular belief, not with that which may have only worked in the solitary brain of the eccentric thinker"; and as he several times records his conviction that "a religion without a personal god has not yet been found to be a living and enduring force," the survey is practically limited to beliefs of a theistic type. Buddhism, as a popular religion, he holds to be only an apparent exception to the dictum just quoted, but he does not draw upon it for his materials.

Within the limits indicated, Dr. Farnell offers us in this volume from the wealth of his knowledge a fascinating comparative survey of the main aspects in which men have conceived their deities. For belief in a personal god is by no means to be interpreted as equivalent to pure monotheism, and the chapter on "Polytheism and Monotheism" is one of the most interesting in the book. "The only monotheisms, pure, unmixed, and alive, are Judaism and Islamism," while in the past we have the creed of Ikhnaton, the reforming king of Egypt, and possibly the teaching of Zarathustra in its original form. As regards Christianity, Dr. Farnell says "the current popular religion of Europe should be rather described as a high spiritual polytheism tempered and restrained by the Athanasian Creed," while the cult of the Virgin and the saints reminds us that "Mediterranean polytheism was never permanently overthrown, and that many of its fibres survive in the soil of our orthodox Christianity." Similarly he notes that among the higher world-religions the only two that have remained consistently non-idolatrous are the Judaic and the Islamic. The early Christian church "upheld for a time the Judaic ideal, but the spirit of the Hellenic and Mediterranean idol-lover triumphed soon over the spirit of Moses; the resistance of the Byzantine iconoclastic emperors was futile; and the popular religion of Christendom, except within the shrinking borders of Puritan Protestantism, must to-day be called idolatrous." But, as might be expected from the author of "Cults of the Greek States," Dr. Farnell does full justice to the nobler side of "Hellenic idolatry" and its important contributions to religion as well as to art. He emphasises in another connexion the fact that, while wisdom in other religions is exalted as a divine attribute and God's highest gift to men, this is always understood in a moral-religious sense; only in Greek religion do we find the consecration of knowledge as such, the recognition of the life of the thinker and the man of science as divinely inspired and a reflection of the divine activity.

Nature-worship and tribal religion are dealt with in separate chapters, and the progress traced from tribal particularism to the conception of a universal God. A long chapter is devoted to "the moral attributes of God" and another to the attribute of power, while the concluding chapter, on "the metaphysical attributes," leads inevitably to some discussion of the problems of the philosophy of religion, which the author began by setting aside. Power is the earliest attribute of the divine: "the gods or the spirits are imagined as powerful before they are recognised as beneficent or just." With the development of monotheism the divine power is characterised as omnipotence, conceived at an early stage as the omnipotence of an arbitrary despot, but eventually as manifested in the law and order of the universe. The question of miracles and of the real validity and religious value of prayer is shortly discussed in this connexion, and Dr. Farnell recognises here, as elsewhere, "the wide cleavage that at present exists between the highest theistic thought and the popular religion."

In the concluding chapter Dr. Farnell dismisses as valueless for religion the philosophical conception of the absolute, if understood as "the All-in-All of the Universe." "Worship, the accompaniment of all active religion, and Love, the essence of the highest, seem both impossible and irrelevant to the impersonal All-in-All, besides which there is no other." He criticises the metaphysical attributes of eternity and immutability, commonly accepted in philosophical and religious thought as characteristic of the divine. Timelessness, he holds, is inconsistent with creation, and the changeful is not necessarily the imperfect. "If we could imagine an unending series of changes from one perfect state to another, we should not view it with regret; each succeeding state of being or phase of creation might be new but none the less perfect, and the sense of change might become an added joy." The final riddle, how to reconcile the existence of the evil and pain in the world with the ideal of an omnipotent and beneficent God, Dr. Farnell pronounces to be insoluble. After quoting a sentence of Lotze to that effect, he adds: "'Though he slay me, yet will I trust in him' is the highest religious expression for this self-abnegation of the intellect. And this may well be the last word of wisdom." But although such a conclusion may be forced upon us, such self-abnegation is far from being, in his view, a thing to be gloried in; as he puts it on his last page, "a religion that makes intellectual assumptions incurs intellectual obligations, and cannot admit the claim, occasionally made in our pulpits, that incoherence and self-contradiction are proofs of the highest truth."

Steam Condensing Plants.

(1) *Modern Practice in Steam Condensing Plants: a Practical Treatise.* By Arthur R. Wright. Pp. xv+309+vi. (London: Crosby Lockwood and Son, 1925.) 45*s.* net.

(2) *Steam Condensing Plant in Theory and Practice.* By James Sim. Pp. xiii+271. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1925.) 18*s.* 6*d.* net.

HITHERTO the subject of steam condensing plants has not received the attention to which its importance in the achievement of efficient power production entitles it. Difficulties have confronted the student of the subject. In the first place, research has yet much to accomplish in this direction, and further, such information as was available was not in the most accessible form, being principally confined to papers and articles which have appeared sporadically.

Now, almost simultaneously, two books appear, both making a commendable attempt to deal comprehensively with the whole field, and collect the available facts into a form which will be useful to those seeking information on the subject. Both have succeeded extremely well on different lines. One is principally useful for its descriptiveness and its collection of information and references, and the other for its analytical and mathematical treatment of the physics of the subject. Neither touches upon the considerable development which has recently been made in condensers for turbine-driven locomotives, but, presumably, it has been considered that that development, being almost exclusively Continental in origin, is not as yet of interest to the British engineer. Apart from that fact, comprehensiveness is a marked feature in each volume, and, unlike the majority of technical books, they fill a real gap in the library of technical literature.

(1) Mr. A. R. Wright commences his work at the root of the subject by stating in the opening chapter fundamental laws and the properties of steam, but it is unfortunate that the arithmetical errors in the examples given will tend to confuse the novitiate who finds this chapter necessary, and at the same time will create a bad first impression.

The various factors affecting the transmission of heat through condenser tubes are separately discussed and the work of accredited experimenters is effectively summarised. Analysis of their findings is not attempted, but the diagram showing collectively the results of the best known experimenters regarding the effect of cooling water velocity on the rate of heat transmission through tubes is useful. The merits of the various types of jet condenser, high and low level, counter and parallel flow and their adaptability to conditions, are well set out. Ejector, injector, exhaust steam induction and evaporative condensers are similarly dealt with and discussed, in all cases with good diagrams and illustrations. The principles of the operation of cooling ponds and towers are explained, and it is shown that the former will rarely be preferred to the latter. This is an excellent chapter and an exceedingly welcome contribution.

The functions and requirements of the surface condenser and the application of the laws of heat transmission thereto are next dealt with. A good selection of types are illustrated, but in their description, otherwise good, more attention might have been directed to the effect of baffles in maintaining the condensate temperature and to the features aiming at reducing resistance to steam flow across the tubes. Tube corrosion and its prevention are only briefly referred to, but, of course, this is a major problem in itself. The treatment of those important auxiliaries—the air and condensate extraction pumps—is appropriately thorough. Air pumps of every type, reciprocating, steam jet, water jet, rotating jet, and combinations of these, with and without intercoolers and after-coolers, are capably described. The circulating pump, not being exclusively a condenser auxiliary, receives less attention, but its functions and requirements are explained. Brief reference is made to de-aerators, oil separators, vacuum breakers, relief valves, etc. The note on commercial considerations in the choice of plant might have proved a valuable contribution, but the costs given are pre-War, and consequently have not much present-day value, even relatively to each other.

The mathematical treatment is perhaps purposely of an elementary nature, but it requires some revision, and the diagrams in the appendix also require a little attention, while a future edition could with advantage include statements of the performances of actual installations, properly correlated and compared. The book is very well illustrated and is a splendid compendium of the various forms and functions of apparatus relating to the condensation of steam, while the copious references to further sources of information are of great value.

(2) Although the preface states that Mr. Sim's book is written for students, it will have a much wider field than that implies, for on this subject many engineers are much in need of sound information such as is contained in this volume. The book may be summarised as a thoroughly sound application of known physical facts to the design of steam condensing plant. It deals with surface, jet, ejector, and evaporative condensers, air pumps and air ejectors, centrifugal pumps for condensate extraction and for supplying cooling water, evaporators and feed water heaters, in regard to each of which a sound method of design and much valuable data are given, while feed water systems and de-aerators and details appertaining thereto are fully discussed. In all cases some useful examples of the products of well-known manufacturers are illustrated and described. Surface condensers are properly considered the most important, and in dealing with the factors affecting the rate of transmission of heat through the walls of the tubes, the method has wisely been adopted of regarding the resistance to heat flow as being composed of individual resistances which can be separately treated. Data for determining the values of these various resistances are given, and since these data are said to agree with the author's practical experience, which must be exceptionally wide, they should be of great utility. It is true that the figures given for the greatest resistance, that on the steam side of the tube, have a wide variation (in one case the maximum value is twice the minimum), but, in order to cover the great variety of practical conditions, this is unavoidable in a general treatment of this kind.

The selection of a proportion of the known total resistance to be allocated to each separate cause is probably of a somewhat arbitrary nature, unavoidable in the present state of knowledge, but it would appear that the arbitrariness is carried a little further than is necessary. For example, it is not clear why the resistance at the surface of separation of the tube wall and the cooling water should be different in a brass condenser tube and a copper feed heater tube of the same bore, or why this resistance should be different with a thin copper tube and a thick copper tube; again, in regard to the resistance across the tube wall itself, a brass condenser tube 0·048 in. thick has a value of 0·08 ascribed to it, while a copper feed water heater tube 0·064 in. thick has, in the same units, a value of 0·3—several times that estimated with regard to the respective conductivities and dimensions. If there are reasons for these apparent discrepancies, the student would prefer to know them. These comments are made rather in response to the prefatorial request for suggestions than in criticism or lack of appreciation of the general value of the work.

Useful data are given for determining the head necessary to overcome the resistance to flow of cooling water through condenser tubes, pipes, etc. The design of air coolers, their influence on the capacity of the associated air pumps, etc., and the conditions under which their adoption is justified, are lucidly explained. A useful coefficient of condenser performance is suggested involving the terminal temperatures of the steam and cooling water. Air pumps and air ejectors receive the attention their importance demands, and again good methods and useful data are given for determining their proportions to suit the service required.

The mathematical treatment is sound throughout and presented in such a form as to be readily assimilated, while numerous examples are worked out to show practical applications. Instructive examples are also given to indicate how data can be analysed to detect the functioning of an existing apparatus, but that in which the dryness of the engine exhaust is deduced from the condenser temperatures should have been accompanied by a note of warning. The corrosion of condenser tubes is a matter not touched upon, and although it is too wide a subject for full treatment in a general work of this kind, some reference to it, however brief, would be an improvement.

The general value of this publication may be gathered from the fact that in it there is the necessary matter to enable any one skilled in the art to undertake the rational design of condensers and their auxiliaries to meet the ordinary requirements of practice.

L. M. D.

The German Outwash Terraces and the Astronomical Theory of the Ice Age.

Die Gliederung und absolute Zeitrechnung des Eiszeitalters. Von Prof. Dr. W. Soergel. (Fortschritte der Geologie und Paläontologie, Heft 13.) Pp. vi+125-251+3 Tafeln. (Berlin: Gebrüder Borntraeger, 1925.) 8·25 gold marks.

THE revision of the astronomical theory of the Ice Age, usually associated with the names of Adhémar and Croll, and its recasting in a form which seems to show considerable correspondence with the observed facts of geology,[1] has led Prof. Soergel to attempt an interpretation, in terms of this theory, of the complex terrace system of certain German rivers.

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[1] W. Koppen und A. Wegener, "Die Klimate der geologischen Vorzeit." Berlin, 1924.

The Köppen-Wegener curves for the secular variation in summer sunshine for latitudes 55°-65° show four well-marked double minima, corresponding to the four ice ages of the Alps, Günz, Mindel, Riss and Würm, and three intervening periods of variable but on the whole warmer conditions, supposed to be identical with the interglacial periods. The double character of the minima and the excessive length of the middle interglacial period give some grounds for confidence, for it will be remembered that Penck established on geological evidence a double maximum for the Würm Ice Age and proved that the Mindel-Riss Interglacial Period was several times as long as those which preceded and followed it.

Now the valleys stretching away from the Alps exhibit a fourfold terrace system, one terrace for each glaciation, but when we come to the river valleys containing the outwash terraces of the northern glaciation, we find a much more complex state of affairs. Here there are, according to Prof. Soergel's reading, ten terraces, nine of which yield a cold fauna and one a temperate fauna. Eight of these terraces are accommodated by the four double minima corresponding to the Alpine Ice Ages. The curve of summer sun-heat shows, however, in addition to these, many other minima, four of which, though considerably less than those of the Ice Ages, are greater than the others (Fig. 1). They occupy positions as follows: (*a*) Pre-Günz, (*b*) Pre-Riss, (*c*) Pre-Wurm, (*d*) Post-Würm (or Würm 3). The Pre-Günz minimum is supposed to be inoperative, the pole being at that time too distant. To the Pre-Riss and Pre-Würm are ascribed the two "supernumerary" terraces, that with the temperate fauna falling on the Pre-Riss. To the Post-Würm minimum are attributed the Bühl stadium of the Alps and the Baltic re-advance of the northern glaciation. There is no terrace in the German river valleys corresponding to this last minimum. An explanation of this failure is promised on p. 199 [75], but the reviewer has been unable to find it in the subsequent text.

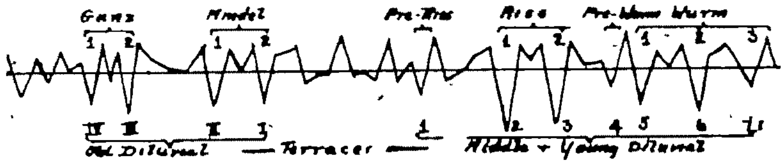

FIG. 1.—Comparison of the terraces of the Ilm with the astronomically calculated curve of summer sun-heat.

A further test of the equivalence of the astronomical and geological records is applied by estimating the erosion which took place between the formation of the terraces, and comparing this with the lengths of the astronomically calculated interglacial periods. No direct relation is observable, and various factors are mentioned as likely to cause abnormalities in this respect. Of these, the most satisfactory is the occurrence of excessive maxima of sun-heat in certain periods in which the erosion is greater than the duration of the period might seem to justify. Crustal movements, changes of sea-level, and hardness of rock are also considered to have an effect, which is, however, less easy to assess.

It is difficult at the present moment to form any well-founded opinion on the merits of an attempt of this sort. One reads it with the fear that it is perhaps merely a renewal of the reckless "pigeon-holing" or fitting of facts into an artificially prepared scheme, which was carried to such extremes by James Geikie and his followers. On the other hand, the scheme on this occasion seems to be based on a securer foundation, and there is a fair amount of fitting between the facts and the theory. It is questionable, however, if this appearance of agreement is beyond the possibilities of coincidence, and the confidence of the reader is far from being reinforced by constantly recurring assertions regarding the conclusiveness of the argument.

The essential portion of the book is followed by a discussion of the importance for geology, palæontology, and archæology of an absolute time scale of this kind. Probable dates in years are assigned to the Palæolithic stages, the chronology of Penck being followed approximately, and the Chelléen being regarded as belonging to the Mindel Riss instead of to the Riss-Würm, where it is placed by Obermaier and the Abbé Breuil. This section is interesting, but the treatise as a whole seems quite unnecessarily prolix, and might with advantage be condensed into half the space.

W. B. WRIGHT.

Fœtal Monkeys.

Angola et Rhodesia (1912–14). *Mission Rohan-Chabot sous les auspices du Ministère de l'Instruction publique et de la Société de Géographie.* Tome 4: *Histoire naturelle.* Fascicule 1: Mammifères (Anatomie comparée, embryologie); oiseaux, reptiles, poissons. Pp. viii + 176 + 18 planches. (Paris: Paul Geuthner, 1923.) n.p.

THIS fascicule contains a systematic account of the birds, reptiles, and fishes collected in Angola and Rhodesia by M. de Rohan-Chabot in 1912–14. But the major portion of the volume is devoted to a report upon the anatomy of two fœtal baboons. The special value and significance of this investigation are due to the fact that it was carried out at the Laboratory of Comparative Anatomy of the Natural History Museum in Paris by such competent and experienced anatomists as Profs. R. Anthony and F. Villemin.

The memoir represents a good deal more than the mere description of the two fœtuses of the Chacma baboon, and the bones of their respective mothers. The authors have collected all that is known of the anatomy of the viscera and skeleton in fœtal monkeys and apes, so that their report forms a very useful and important addition to our knowledge of the comparative anatomy and embryology of the Primates. Moreover, they have directed attention to several very suggestive and novel problems involving the correlation of function with morphology. It is not possible within the compass of this notice to summarise all the provocative hypotheses they put forward in a tentative way. Hence I must content myself with a reference to one of them.

While the fœtal kidney in man is lobulated, those of the tailed monkeys and lemurs are smooth, and the condition found in the anthropoid apes is intermediate between the catarrhine and the human. Discussing this curious phenomenon, the authors invoke the influences of climatic conditions and size of body as factors that play a part in causing lobulation. In 1922 Prof. Anthony discussed the reasons for the persistence into the adult stage of obvious lobulation of the kidney in such mammals as whales, elephants, bears, etc.; and he put forward the suggestion that the reduction of the relative extent of the skin (and of the ability to get rid of waste products by sweating) in proportion to the bulk of the body in large creatures was compensated by the increased activity of a kidney broken up into a large number of lobes. The fact that certain small mammals also have lobulated kidneys he explained by the fact that they live in cold climates, which reduces the sudorific activities of their skin.

In this memoir the authors attempt to apply these hypotheses to explain the conditions found in the Primates. In man and the giant anthropoids the great size of the body is a reason for lobulation of the kidney, which is less pronounced in the apes because they ive exclusively in tropical climates. The authors state hat in fœtal negroes from Africa the lobulation is less pronounced than it is in Europeans, and claim that this esemblance to the anthropoids is due to the fact that, ke the latter, the kidneys of these tropical Africans have been influenced by the climatic conditions under which they live.

Such far-reaching conclusions obviously call for a wider basis of evidence than is yet available before hey can be accepted as the true interpretation of the acts.

G. ELLIOT SMITH.

Our Bookshelf.

Structure des molécules. Par Prof. Victor Henri. 1: Polarité des molécules; 2: Structure des molécules déterminée par les rayons X; 3: Spectres d'absorption des vapeurs et structure des molécules; 4: Prédissociation des molécules; 5: Structure du benzène et de ses dérivés. Conférences faites au laboratoire de Ch. Moureu et à la Société de Chimie physique. (Publications de la Société de Chimie physique, 12.) Pp. ii+122+1 planche. (Paris: J. Hermann, 1925.) 20 francs.

Now that our knowledge of the structure of the atom is beginning to be very definite, it is natural to turn to the molecule. Here a much more complex problem presents itself, but, of recent years, several promising lines of investigation have been developed. As is to be expected, stress is laid on the interpretation of absorption spectra, a subject which Prof. Henri has made peculiarly his own. These spectra are exceedingly complicated, but it is now possible in many cases to identify the separate effects of the rotation of the molecule, the vibrations of the component atoms and the movements of the electrons. From these measurements it is possible to calculate the energy of the molecule in its various states of activation. Emphasis is laid on one important general result among others: that while in the normal state and the early states of activation the rotation movements of the molecule are subject to quantum restrictions, at a certain stage of activation this quantisation ceases. To this state Prof. Henri gives the name "predissociation" and claims that it is the necessary prelude to chemical action and combination.

In a short chapter devoted to X-rays and molecular structure the author is clearly on less familiar ground. Here a few errors have crept in, notably in his discussion of the symmetry of the benzene ring, where he misquotes Bragg as suggesting a model with symmetry properties which are actually mathematically impossible. The first chapter gives a lucid account of the electrical moments of molecules, while the final chapter is devoted to the vexed question of the structure of the benzene ring. A new suggestion is made which the author claims is in better agreement with the facts that are at present known than any of the older models. The book contains a very useful summary of the recent methods of attack on the question of molecular structure, and the reader can scarcely fail to be interested in and impressed by the progress made on a problem which only a few years ago appeared almost impossibly complicated.

Public Health in Theory and Practice: an Historical Review. By Dr. William Henry Welch. Pp. viii+51. (New Haven: Yale University Press; London: Oxford University Press, 1925.) 4*s.* 6*d.* net.

THIS little book, which is the eighth work published by the Yale University Press on the Williams Memorial Publication Fund, is the second annual lecture in commemoration of William Thompson Sedgwick, the pioneer in American hygiene, a memorial volume to whom we noticed in our issue of March 14, 1925, p. 372. Dr. William Welch, who is Director of the School of Hygiene and Public Health at Johns Hopkins University, Baltimore, shows that the justice of Sedgwick's claim that "the sanitarian needs a proper working theory" has been well illustrated in the history of preventive medicine, especially in the work of Fracastorius, Sydenham, Jenner, Sir George Baker, James Lind, Sir John Simon, and Pasteur. It is pointed out that inadequate and even erroneous theories which bear some relation to the state of contemporary knowledge may serve a useful purpose, as was exemplified by the doctrine of the so-called "filth theory" of the generation of epidemic diseases, especially typhus, typhoid, and dysentery, inasmuch as the acceptance of this theory led to a campaign for the supply of pure water, the proper disposal of sewage, the prevention of water pollution, the removal of nuisances, cleanliness of the streets, inspection of food, healthfulness of dwellings, ventilation, and proper disposal of the dead.

In conclusion, Dr. Welch deplores the lack of active participation on the part of the general medical profession in public health activities, the fault being partly due to encroachment on the field of the private practitioner and partly to a lack of sympathy and co-operation with health officials and with health programmes on the part of the practitioner.

General Zoology. By Prof. H. L. Wieman. (McGraw-Hill Publications in the Zoölogical Sciences.) Pp. ix+312. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 15*s*. net.

THIS book "is a rather condensed account of some of the outstanding facts and principles of zoology" prepared for use in conjunction with the author's course of practical teaching, and it is evident that a clear understanding of many of the subjects must depend largely on the work on structure and on histology done in the laboratory. The first eighteen chapters of the book deal with adaptation, the various systems of organs, metabolism, cell division, gametogenesis, ontogenesis, evolution and heredity, and a concluding chapter gives a "general survey of the animal kingdom" in fifty pages. The best chapters, in our opinion, are those on evolution and heredity; many of the other subjects are treated so briefly as to be largely ineffective, *e.g.* reproduction—agamic, hermaphroditic and bisexual—intrauterine development and certain general considerations are traversed in eight pages, more than two of which are occupied by illustrations. The author should have eliminated a number of loose statements, *e.g.* that the ilium of the frog "extends dorsally to the scapula," that the setæ of earthworms are arranged in clusters, and should revise his usage of the term nephridium. The illustrations are carefully chosen and well reproduced.

Manufacture, Design, and Laboratory Work. Compiled and collated by D. V. Onslow. (Electrical Engineers' Data Books, Vol. 2.) Pp. xvi+276+cxcv+9. (London: Ernest Benn, Ltd.; Radio Press, Ltd., 1925.) 15*s*. net.

ENGINEERING data of the manufacture and design of electrical machinery and also descriptions of tests which are useful in laboratories and testing rooms are given in this work. The book opens by discussing the electric strength of insulating materials, and we gather that electric strength has something to do with "average breakdown voltage." The impression left on the reader, however, is that possibly there is no such thing as "electric strength" after all. The scientific man will be appalled at the many trade names of insulating materials. The methods of testing devised by members of the various research committees have strictly practical ends in view, and a large "tolerance" has to be allowed for the results. We have a difficulty in understanding what is meant by saying that the power factor for clear micas is 0·003. The phrase "dielectric constant" is rather an unfortunate one, when we have to discuss how it varies with temperature, humidity, etc. In the appendix it is called specific inductive capacity. The type in which the mathematical tables is printed is difficult to read. In our opinion it is time that the so-called "international and B.O.T. units" were placed on the scrap-heap. The ampere, the volt, and the ohm have been determined with an accuracy far in excess of that required in commerce.

Abhandlungen zur Physiologie der Sinne aus dem physiologischen Institut zu Freiburg i. B. Herausgegeben von J. von Kries. Fünftes Heft. Pp. iv+120. (Leipzig: Johann Ambrosius Barth, 1925.) 4 gold marks.

IT is much to be regretted that in Great Britain there is a decay of interest in the physiology of the special senses. Among representative physiologists, there are extremely few who might be called special sense physiologists. The present volume bears witness, however, that this is not the case in Germany. The volume is a convenient fasciculus, the fifth of its kind, forming in reality a reprint of collected papers published from the school of von Kries in the *Zeitschrift für Sinnesphysiologie*. The papers describe congenital colour-blindness in one eye (J. von Kries), similarity of taste in mixed solutions (E. v. Skramlik), minimal luminosity in colour sense (E. Engelking and F. Poos), and the geometric representation of multiplicity of sensations (J. von Kries). Each contribution must be studied first-hand for its merits.

L'Hydrogène et les gaz nobles. Par Dr. J. J. Van Laar. Pp. ii+79. (Leyde: A. W. Sijthoff, n.d.) n.p.

THIS monograph is the first of a series on theoretical and practical chemistry to be issued in French or English under the auspices of the Société Chimique Néerlandaise. Devoted exclusively to consideration of numerical data relating to the physical properties of the gases specified in the title, it will be welcomed by all workers in this branch as a trustworthy, well-arranged, and reasonably up-to-date book of reference

Exercises in Geometry. By V. Le Neve Foster. Part 1. Pp. viii+69. (London: G. Bell and Sons Ltd., 1925.) 2*s*.

MR. FOSTER thinks it is not inconvenient to add to the number of riders given in the text-books. If he is right, it would be difficult to provide a better collection than this, which is intended to be used in Stage I. when the stress is laid upon the practical sid of geometry.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Hardness.

AMONGST the many properties of solids which are the subject of measurement, none are less satisfactorily specified than that of hardness. Two kinds of hardness may be distinguished, namely, surface hardness and body-hardness, though the distinction is often disregarded. Mineralogists deal with surface hardness, and of any two bodies call that the hardest which will scratch, but not be scratched by the other. On this system an arbitrary scale has been evolved having diamond (Hardness 10) at one end and talc (Hardness 1) at the other.

Engineers are chiefly concerned with body-hardness, which (in the most usual test) is measured by the depth or diameter of the impression left on the surface of the material tested, when a hard steel ball is pressed against it by a known force. Other forms of test are also in use, but in all cases the hardness is given by a number and not in mechanical units. Body-hardness, however, may be simply defined as the greatest normal pressure which a surface will bear without rupture. More than twenty years ago I tried to get the Ordnance Committee to have its hardness tests stated in this way, but nothing came of it.

In scratching tests the conditions are more complex. The harder of the two bodies exerts a tangential drag on the surface of the softer, and a scratch is produced when this drag exceeds the limit of distortion at a free surface. The coefficient of friction between the pair is, therefore, involved; and it is probable also that the distortion limit at the surface may differ from the corresponding limit for the interior from causes analogous to those which produce surface tension in a fluid. Even for body-hardness the same cause may operate to a small extent.

It may happen, therefore, that the scratching and indentation tests indicate different degrees of hardness in the same material.

As regards indentation tests, it must be noted that they are of use only when the indenting body is much harder than the indented, and also when the limits of elastic deformation of the latter are small. The ball test, for example, applied to a sheet of india-rubber would indicate infinite hardness, since no permanent impression could be made.

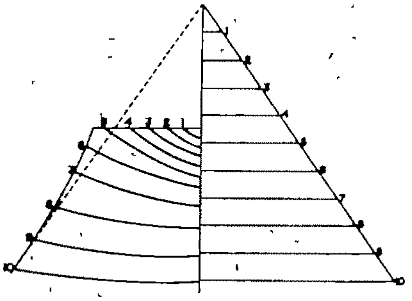

FIG. 1.—Showing the deformation which occurs when the apex of a cone is flattened. The curves are copied from an axial section of a cone built up of coloured strata of plastic material.

In the course of some experiments made during the year 1925 on the properties of various steels, I have had occasion to make many measures of their hardness, and for this purpose have employed a method which is free from some of the above objections.

A small piece of the material to be tested is shaped into a circular cone which is placed point downwards in a loaded vertical holder, provided with a means of slowly lowering the point until it rests on, and is entirely supported by, a hard flat surface. The pressure flattens the point of the cone until the area of contact is sufficient to carry the load, and the diameter of the flat is then measured with a microscope and micrometer.

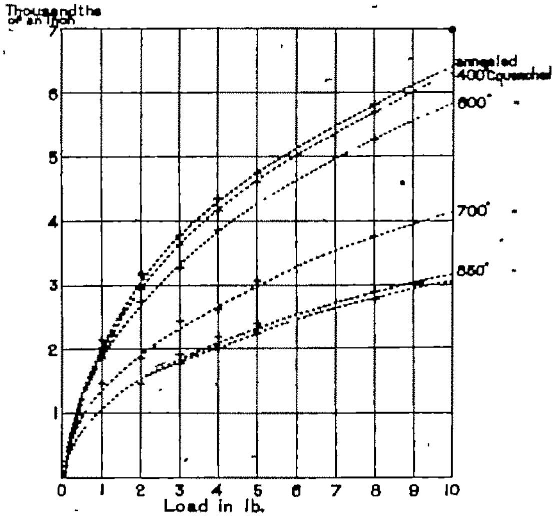

FIG. 2.—The ordinates are the diameter of the flats formed by pressure on the apex of cones of carbon-steel (Stubbs's steel rod) when hardened by quenching at different temperatures. The abscissæ are the applied loads

In these experiments the hard surface was a piece of polished sapphire. Diamond no doubt would be preferable, but a suitable stone would have cost as many pounds as the sapphire did pence, and sapphire is so much harder than any of the metals that in this case the results would be identical.

The nature of the deformation set up in the flattened cone is shown in Fig. 1.

If the coefficient of friction between the surfaces over the area in contact is known, the deformation curves can be calculated, and it can be shown that the pressure is nearly uniform over the whole surface, but in the figure they are copied from an experimental model. Sheets of a plastic substance of uniform thickness and quality, but differently coloured, were placed on one another, and from the stratified block thus formed, a cone was cut by means of a properly guided and tightly stretched fine steel wire. The cone was then pressed against a flat plate by a motion parallel to the axis, and an axial section cut showing the distortion of the strata.

For any given angle of cone the curves are similar, whether the flattening is large or small; and supposing that the material is isotropic, that is, neglecting any peculiarity belonging strictly to the surface layer, hardness may be estimated by the pressure between the two plane surfaces involved.

If D is the diameter of the flat, this pressure is Load $\times 4/\pi D^2$, and for any particular material D should be proportional to the square root of the load. The experimental results illustrated in Fig. 2 (and in the many similar diagrams which have been plotted) show that this is actually the case. In this figure the ordinates of the dotted curves are proportional to the square root of the abscissæ which represent the loads, while the crosses are the measured diameter of the plate. If the diameter of the flat is n thousandths of an inch and the load on the cone is m pounds, the pressure on the flat is $565m/n^2$ tons per square inch (nearly).

A series of curves for various values of m (see Fig. 3) (in which the ordinates refer to n and the abscissæ pressure) may be drawn so that the hardness for any values of n and m may be found by inspection. Fig. 2 relates to Stubbs's steel rod hardened by quenching in water from different temperatures. When softened by slow cooling the hardness is less than 100 tons per square inch.

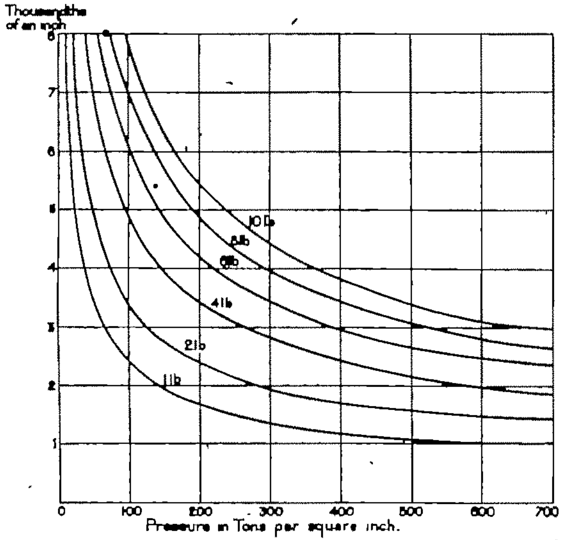

FIG. 3—Diagram to enable the hardness of a material to be determined by inspection for any load and diameter of flat. The ordinates are the diameter in thousandths of an inch, and the abscissæ the hardness in tons per square inch.

The maximum hardness is attained when the quenching temperature is rather lower than 900° C. and is then well above 600 tons per square inch. It was a surprise to me that any metal could withstand such a pressure without crushing.

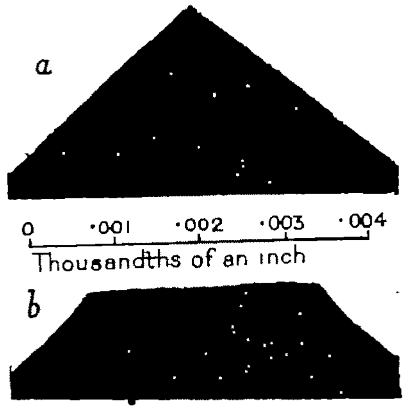

FIG. 4.—Photographs of a hard steel cone (a) Untouched, (b) after the application of a pressure of 610 tons per square inch.

In Fig. 4 two photographs are given of the same steel cone before and after this pressure was applied. A few measures of the effect of tempering have been made, and these are included in the subjoined table, but they will be repeated in greater detail.

In the case of alloy steels the effects of quenching are very complex, sometimes increasing and sometimes diminishing the hardness, and the differences in their behaviour seem to have no simple relation to the proportions of the alloying metals (manganese, chromium, and nickel), but none of them under any conditions which I have tried approaches the hardness of carbon steel.

For the softest of my specimens (36 per cent. nickel) the hardness was about 70 tons, and for the hardest (13·5 per cent. chromium) 300 tons.

HARDNESS OF VARIOUS MATERIALS.

The hardness is stated as the maximum pressure which the surface of the material will withstand.

Soft Iron.	Hardness Tons per sq inch	Remarks.
1	68	Nearly pure iron about 0·04 per cent carbon
Carbon steel		Stubbs's steel rod
1	150	" " as sold.
2	155	Annealed by slow cooling from dull red heat.
3	158	Quenched at 400° C.
4	164	" 600°.
5	265	" 700°.
6	540	" 850°
7	610	" 900°
8	500	" 800°, tempered at 100°.
9	350	" " Straw yellow.
10	290	" " Blue

Alloy Steels	As from the Rolls	After Quenching at 900°.	Composition of Alloys per cent.				
			C.	Si.	Mn.	Cu.	Ni.
1	190	165	0·15		5·4		
2	197	220	0·15		15·3		
3	250	330	0·35	0·22	0·13	13·6	
4	112	265	0·43	0·32	0·25	3·3	
5	114	210	0·19	0·20	0·65		4·0
6	94	75	0·16	0·03	0·86		36·0
7	145	135	0·6		5·0		15·0
8	93	Sample of Invar	Analysis not known.				

Miscellaneous.		
Brass	70	Hard drawn commercial rod.
Copper	39	16 B W.G. wire.
Aluminium	24	Commercial drawn rod
Tin	7·25	Commercial
Lead	5·3	Commercial
Beeswax	0·14	At 14° C The hardness varies rapidly with the temperature.

As bearing on the accuracy of the measures here given, it will be seen on reference to photograph *b*, of Fig. 4, that the angle between the flat and conical surface forms very definite positions on which to adjust the micrometer wire. With the magnification employed, each division of the micrometer was equivalent to rather less than one sixteen-thousandth of an inch. Repeated readings of the length of the same diameter seldom varied by more than one micrometer division. For the hardest metals this diameter was of the order of 0·003 in., so that the linear error would not exceed 2 per cent. and the error of area 4 per cent.

It was found, as might have been expected, that near the apex of the cone the cross section was generally somewhat oval, and for this reason two diameters at right angles to one another were always measured and their mean used in computing the area.

Taking all sources of error into account, I believe the results to be generally correct within 5 per cent.

A. MALLOCK.

9 Baring Crescent,
Exeter,
December 15.

Phenological Observations and Results in Russia.

PHENOLOGICAL studies are not a new branch of scientific research in Russia; they have, indeed, a long history.

After the first efforts to make and to publish phenological observations, the attempts of N. Annenkoff in Moscow (1844–49), of A. Doëngingk in Kishinev (1845–60), and of Prof. A. Voeikoff (1885–95), phenological observations were established on a real scientific basis and were carried on during the long period from 1888 to 1923 by the Russian pioneer of this branch, the late professor of the Institute of Forestry, D. N. Kaigorodoff. He not only made very careful personal phenological observations every spring and autumn in the Lesnoi Park, near Petrograd, but organised them also over all Russia by many correspondents, whom he had recruited.

After Prof. Kaigorodoff's death in 1923, at the age of seventy-seven years, his work was taken in hand by the Russian Society of Amateurs of the Study of the Universe ("Obstchestvo Mirovedenja"), an entirely private society of amateur astronomers and meteorologists.

This Society elected a special Phenological Committee, which undertook the organisation of a large network of phenological observation points and also the compilation, study, and publication of the results. Through appeals to its correspondents and through propaganda in newspapers, the committee has greatly developed this during the last two years. In the year 1924 there were 258 observers, corresponding with the committee, in 223 different stations in the U.S.S.R., and in the spring of 1925 the number of observers increased to 608 at 512 points. At nearly 75 points in European Russia phenological observations had been made for periods of 10-20 or more years.

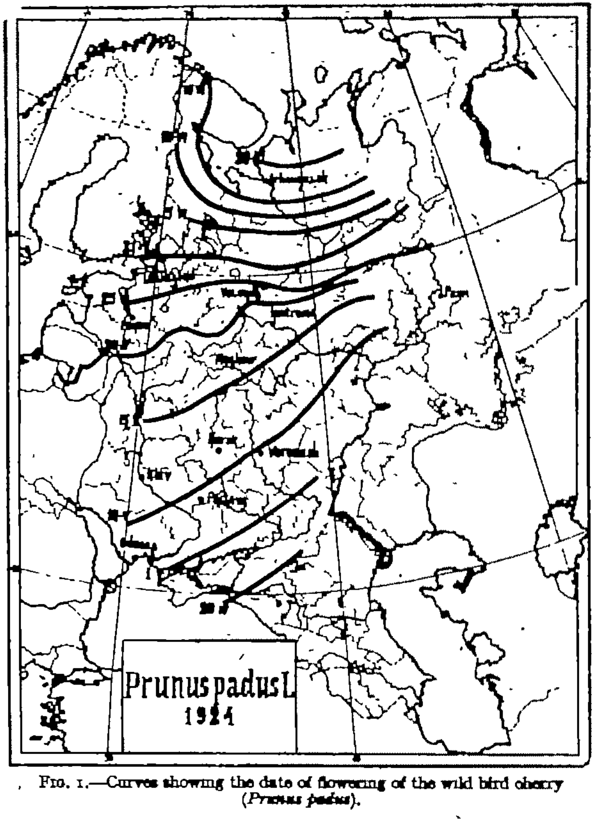

FIG. 1.—Curves showing the date of flowering of the wild bird cherry (*Prunus padus*).

Besides these points of observation of the committee there is a network of 58 points organised by the Meteorological Bureau of the Ukraine (South Russia).

The study of the large series of observations made at different points and during a long series of years permitted the Phenological Committee to draw up a table of the mean times of different natural phenomena at 17 typical centres distributed over all European U.S.S.R.

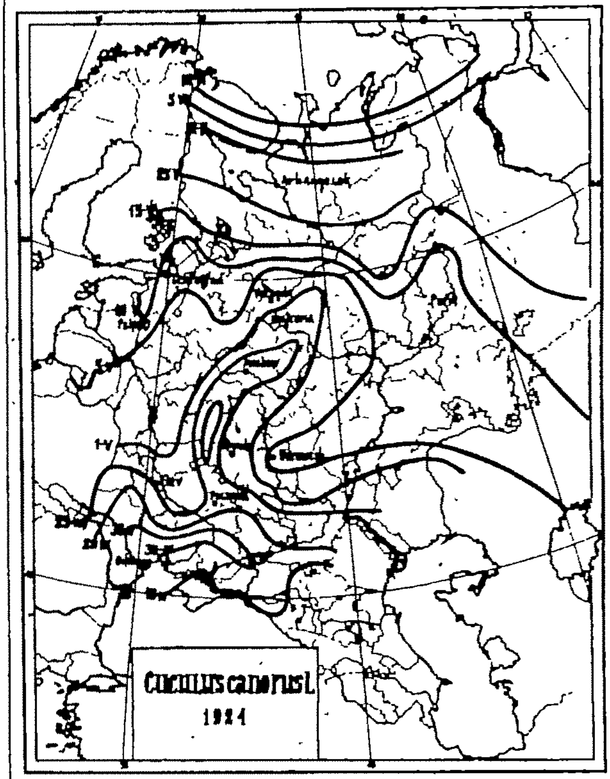

FIG. 2.—Curves showing dates when the cuckoo was first heard.

This table affords the possibility of comparing the natural phenomena of every spring and autumn with the mean times, and of deciding how far either event is too early or too late in the present year.

Such observations compared with results of the meteorological observations show generally a coincidence with weather conditions. A more precise idea of the gradual procession of the natural phenomena and of their dependence on meteorology can, however, be obtained also in another manner. Having a dense network of observation points, we can easily draw curves of isochronous events—*isopiptesses* in the case of the arrival of birds, and *isoanthes* for the flowering of plants.

The Phenological Committee has tried to draw some curves for the spring of 1924, and also for the spring of 1925, and has obtained very interesting results.

The isoanthes in 1924 of the earlier plants (Fig. 1), as, for example, of the flowering of the wild bird cherry (*Prunus padus*)—a tree very common and widely distributed in Russia—in the south and middle part of U.S.S.R. lie in a N.E.-S.W. direction, showing that in the east part the flowering began earlier than in the west part of the country, where it was retarded by some unfavourable conditions. But in the north part they lie quite regularly in a later period, 25, v.-20, vi. (Roman numerals refer to months of the year) The flowering of the lilac (*Syringa vulgaris*) shows nearly the same conditions.

The first cry of the cuckoo (Fig. 2) gives greater complications: the curves make a large tongue-like projection to the north, showing that the arrival of this bird was retarded in the east as in the west, but that it succeeded in progressing on the nearly meridional line Poltava — Moscow — Kostroma — Vologda in the central part of U.S.S.R.

The explanation of this strange direction of curves is given by the study of the isobars of this spring. The isobars of 20, iv. are nearly parallel to the latitudes, as also are the isopipteses of the cuckoo at this time. But on 23, iv a very strong cyclone burst in from the north-west and occupied the whole space between the Baltic and the Black Sea. The temperature fell and snowfall was recorded everywhere in this region so far as Kursk and Voronesh. The distribution of winds in this cyclone was such that in the middle part of Russia they were directed from south to north, and this is observed quite on the line Poltava—Moscow—Kostroma. West and east of this line the winds blew in the opposite direction. By these winds the cuckoo was driven northwards on the given line and retarded west and east of it.

On 5, v. the isobars changed in such a way that in the north-east of Russia a strong anticyclone formed in the region of Volga and Kama. Therefore we see on the isopipteses of 10, v. and 15, v. that the cuckoo was rapidly progressing in this direction and heard, 10, v., north of Perm. New cyclones formed in the north-west part brought the cuckoo also to Novgorod and Pskov, and on May 10 it was heard not far from Leningrad.

These examples show us that by the existing large network of phenological observation points in the U.S.S.R. one can get results of great general interest. But incomparably more generalised and more interesting results could be obtained from the phenological observations if they were conducted in the same manner and with the same objects also in western Europe, so that diagrams could be traced covering the whole continent. For this purpose the programmes of phenological observations in the various countries, as also the methods of observations, must agree in general characters.

It seems to us that the best way for establishing such an agreement between the observations of different countries would be the organisation of an International Congress of Phenology, or of a special Section of Phenology at the next International Meteorological Congress. Such a gathering of specialists could discuss and fix the most appropriate list of objects for observation in every country, and it could elaborate also the best methods of observation, study, and publication of phenological phenomena.

Only by international agreement and co-operation can phenology—this link connecting biology and meteorology—be promoted to further development.

P. J. SCHMIDT.

(Curator of the Zoological Museum,
Russian Academy of Sciences.)

Leningrad.

Relative Intensity of X-ray Lines.

THE development of the theory of atomic constitution has made measurements of the intensity of lines in X-ray spectra very important. Estimates of relative intensities of X-ray lines have hitherto been attempted by means either of the ionisation chamber or the photographic plate. Owing, however, to the lack of precise knowledge of the relative sensitiveness of these methods for different wave-lengths, the comparison of intensities of lines which differ in wave-length has involved a considerable uncertainty. To overcome this difficulty, absolute measurements of the energy of X-ray lines based on the bolometric method have been attempted by several workers. Since the wave-lengths used lie on the short wave-length side of the bromine *K*-absorption edge, the sensitivity curve for the photographic plate obtained in this way cannot be applied to measurements of the relative intensities of the *L*- and *M*-series of most elements. To obtain the sensitivity curve in this region, we have exposed plates to X-rays from different metals excited under conditions which can be discussed on the basis of the theory of X-ray production.

In a vacuum spectrograph of the Siegbahn type the four faces of an anticathode, which were covered with sheets of iron, cobalt, nickel, and copper, were exposed in succession by turning the anticathode from outside. The X-ray tube was run off a high tension transformer with a rectifier under constant working conditions, the effective value of the applied voltage being about 20 kv. The vacuum was maintained by a mercury vapour pump working continuously. To make our result as free as possible from accidental errors, especially those which might arise from a variation of the electron emission of the filament or of the vacuum in the tube, a large number of photographs was taken on the same plate, the sequence of exposure of the faces of the anticathode being varied. The blackening of the plate was measured by means of a Moll microphotometer, and relative values of the maximum blackening for the K_α and K_β lines of the four elements were obtained.

In order to utilise the information contained in these measurements for comparing intensities, we have made use of the following theoretical expression for the intensity of characteristic X-ray lines deduced by Rosseland (*Phil. Mag.*, vol. 45, p. 65, 1923):

$$F = Ci\frac{Nl}{V^2}\left\{\frac{V-V_0}{V_0} - \log\frac{V}{V_0}\right\}\nu,$$

where i is the current through the tube, N the number of atoms per unit volume of the anticathode, l the range of the cathode rays in the anticathode, V the applied voltage, V_0 the critical voltage for the excitation of the line under consideration, ν its frequency, and C a quantity which has the same value for homologous lines of the spectra of different elements. In this equation the value of l was obtained by interpolation from Schonland's results (*Proc. Roy. Soc.*, 108, p. 187, 1925) on the dependence of l on atomic number for various voltages. Although in the deduction of Rosseland's formula certain assumptions are made which are only fulfilled if the velocity of the cathode rays is large compared with the velocity ascribed to the electrons in the atom, this formula can be shown to account closely throughout the range of our measurements for the dependence of the intensity of X-ray lines on the applied voltage as determined by Wooten (*Phys. Rev.*, 13, p. 71, 1919) and Unnewehr (*Phys. Rev.*, 22, p. 529, 1923). It is therefore reasonable to expect that this formula will also hold with an approximation sufficient for our purpose as regards the variation of the intensity of X-ray lines with the critical voltage and the other factors which depend on the element.

On this assumption we obtained for a given photographic plate and crystal in the spectrograph a curve of the relative blackening as a function of wave-length. We were thus able to compare the intensities of the lines in the *L*-series of tungsten. For example, we found

$$L_{\alpha_1} : L_{\alpha_2} : L_{\beta_1} = 100 : 10 : 33$$

as the relative intensities corresponding to our experimental conditions. Since the critical excitation potentials for these lines are not quite the same, the relative intensities will depend on the applied voltage.

Correcting for the difference in the critical potentials by means of Rosseland's formula we obtain

$$L_{\alpha_1} : L_{\alpha_2} : L_{\beta_1} = 100 : 10 : 43 .$$

as the intensity ratio to be expected for an applied voltage very large compared with the difference of the critical potentials.

It is of interest to compare this result with the intensity relations of optical spectra. For the lines ***np-md*** of the alkalies, which have a formal analogy with the above X-ray lines, one would expect 9 : 1 : 5[1] (100 : 11 : 55) Here the measurements in Utrecht have given results agreeing with the theory. Although there is a close resemblance, it seems that our values differ from this ratio by more than the experimental error which we estimate at 5 per cent. Such a deviation is, however, not unexpected, since the theoretical result is only strictly valid so long as the frequency difference of the lines is very small compared with their frequencies. While this condition is fulfilled in the case of the doublets ***np-md*** of the alkalies, we meet in our case with a frequency difference of 15 per cent. which can scarcely be considered to be small.

We hope later to publish an account of the experimental details and of further measurements.

Y. NISHINA.
B. B. RAY.

Universitetets Institut for teoretisk Fysik,
Copenhagen.

The Convection of Light by Moving Matter.

IN the paragraph under the above title, in NATURE of December 26, p. 948, a new question is put forward quite distinct from the discussion of Einstein's theory, dealt with in my unpublished letter of November 5, to which it refers.

The writer of the note, having noticed that I do not belong to that multitude who blindly follow Einstein, seems to conclude that I am of the Einstein-antagonist party, all of whom aim more or less to return to older ideas Even a scientist of well-deserved universal repute, such as Prof. Lenard in Berlin, in his polemic and anti-Einstein pamphlets, which have been reprinted many times, only proposes older theories in a somewhat modified form. But is that generally existing conformity a valid excuse to attribute to me what as a matter of fact is only the impression of the writer of the note ?

It obliges me to state emphatically that there is not the least essential connexion between the writings of all those Einstein-antagonists and my papers. I challenge the writer to point out in my papers (*C.R*, vol. 175, 1922, p. 574, and *Phil. Mag.*, Ser. 6, vol. 49, 1925, p. 579) a single word which may be interpreted as my advocating a return to older electromagnetic theory.

According to the paragraph, my " deduction is not entirely free from ambiguity, in so far as equation (11) in his earlier and more fundamental paper leads at once to the expression $\mu'_w = \mu + A(n' - n)$. . . . For A, which is a constant of integration, M. Menges puts $(\mu - 1)/n + d\mu/dn'$."

As to this, I can only say that neither the reasoning nor the formulæ is to be found in my papers.

My equation is :

$$\frac{d\mu'_w}{dn'} = \frac{\mu'_w - \mu}{n' - n}.$$

This is not given in NATURE. It is immediately obvious that the expression presented in NATURE as the solution of my equation is incorrect. For it may be written :

$$A = \frac{\mu'_w - \mu}{n' - n},$$

which, as a solution of my differential equation, is absurd.

Within the scope of a letter, it is quite impossible to explain my new formulæ fully. I must refer the reader to my books "Nouvelles vues Faraday-Maxwelliennes" and its "Supplément" (Gauthier-Villars and Co., Paris, 1924). There he may see that my mathematical deduction is quite free from ambiguity and undoubtedly correct, and that it leads to the true solution of the question. He will find also that it is by no means by returning to, but, on the contrary, by radical departing from older electromagnetic theory, that my new results are obtained. My new formulæ and new insight in electromagnetism, confirmed by experiment, then leads to the result that Einstein's theory is inadmissible.

CHARLES L. R. E. MENGES.

The Hague,
December 30.

M. MENGES seems to have misunderstood the drift of my notice, which was intended as a *critical review*, not an *abstract*, of his two published papers, without any direct reference to his unpublished covering letter at all. I am not conscious of having attributed any views respecting Einstein's theories, either for or against, to M. Menges, whilst the references to Newtonian principles and the older electromagnetic theory followed naturally from the *Phil. Mag.* paper and its references to the books of Jeans and H. A. Lorentz. I added the reference to v. Laue's paper for the sake of completeness, for it shows that the experiments of Fizeau and Zeeman do not lead to the result that Einstein's theory is inadmissible, as M. Menges states in his letter.

The paragraph of which M. Menges complains is a criticism of his solution (12), not a reproduction of his method of deriving it from his equation (11), for he gives no details in his papers. If we write $n' - n = x$, $\mu'_w - \mu = y$, n and μ being constant parameters, (11) reduces to $dy/dx = y/x$, which is the familiar differential equation of a plane pencil of straight lines through the origin. Its *general* integral is $y = Ax$, where A is the constant of integration ; I fail to see the absurdity of this well-known solution, for its verification is immediate. The point of my criticism is that M. Menges' solution (12) is only a *particular* integral, obtainable of course by choosing a particular value of A ; in the papers specifically referred to, M. Menges gives no sufficient reason why this particular integral should be selected rather than any other. It may well be that good reasons are given in his book, but I have not had access to it My wording no doubt is liable to misconstruction : it would have been better to write : " We can obtain M. Menges' solution (12) by putting for A the particular value $(\mu - 1)/n + d\mu/dn'$."

THE WRITER OF THE NOTE.

Mullet as an Enemy of the Oyster.

DURING the past summer large numbers of oysters carrying larvæ were examined in the Plymouth laboratory, and in order not to waste the larvæ, batches were thrown as food into an aquarium tank containing anemones, sea-cucumbers, small fishes, and other smaller marine animals. After throwing the larvæ into the tank, the animals being fed were watched, and it was found that a small school of small grey mullet (*Mugil chelo*) in the tank came rapidly towards the clouds of larvæ and greedily ate them up. These mullet soon became accustomed to being fed on larval oysters, and quickly appeared from remote portions of the tank when larvæ were thrown in.

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[1] D. Coster and S. Goudsmit, *Naturwiss.*, 13, p. 11, 1925, A. Sommerfeld, *Ann. d. Phys.*, 76, p. 284, 1925.

The manner in which the mullet obtained the larval oysters from the water is remarkable for a fish. The fishes entered the cloud of oysters and while remaining poised or practically still, very rapidly drew water in at the O-shaped mouth and expelled it out through the gill-slits, by using the walls of the oral cavity as a pump. The action is an accentuation of the ordinary breathing mechanism. Obviously also the water passing into the mouth was sieved, as the cloud of larvæ in the water soon cleared on the advent of a number of the little fishes.

Cunningham ("Marketable Marine Fishes," p. 335) records the presence of minute molluscs in the stomachs of mullet, and Day ("British Fishes," i 229 and 234) points out that there is "a filtering apparatus in the pharynx which prevents large and hard substances from passing into the stomach, or sand from obtaining access to the gills"

The mechanism which prevents sand from passing the gills is not unlikely used for filtering off plankton organisms, such as oyster larvæ, as food. It is the more probable that young mullet and to some extent older fishes are partially general plankton feeders, since Day also records the occurrence of minute Crustacea in the stomachs of mullet.

Since mullet abound in some of our estuaries where oyster beds occur, it is practically certain that those and also other small fishes take a toll on oyster larvæ, as Lebour (*J.M.B.A.*, 12, 3, p. 464) has shown that young sprats may do. In a recent publication ("The Story of the Oyster," *Australian Museum Magazine*, ii., 1925) T. C Roughley states, without, however, giving any details, that Australian mullet destroy oyster larvæ; thus it would appear that the mullet family in different parts of the world feed in a similar way.

Although there can remain little doubt that young mullet are enemies of oyster larvæ, the critical test would be derived from the examination of stomachs of fishes taken over or near an oyster bed in summer, and especially in the period preceding new moon Such material will, however, not be easy to obtain.

J. H. ORTON.

The Laboratory,
The Hoe, Plymouth,
December 24.

Absorption and Resonance Radiation of Excited Helium.

PASCHEN in 1914 published results of experiments on absorption and resonance radiation in weakly excited helium. A more extensive investigation is being made of absorption in excited helium, and results have been obtained indicating absorption of the following lines:

5875 3889 5016 6676
4471 3187 3964 4921
4026 3614

It was observed that 3889 was very strongly absorbed, and it was decided to attempt to detect resonance radiation. Light from an intense capillary was focussed by means of a cylindrical lens along the axis of the resonance tube. This served as a strong source of monochromatic radiation of wave-length 3889 Å.U. The resonance tube was focussed, end on, on the slit of a quartz spectrograph adjusted with a wide slit. A series of three photographs was then taken, namely:

1. With the weakly excited resonance tube alone and the light from the capillary screened off.
2. With the resonance tube as in the first exposure and the light from the capillary incident on the resonance tube.
3. With the resonance tube off but the light from the capillary still focussed as in the second exposure.

Examination of the plate showed a barely detectable trace of scattered light. Under the influence of the monochromatic radiation from the capillary, a great increase of the intensity of the radiation of wave-length 3889 Å.U. from the central portion of the resonance tube, on which the light from the capillary was focussed, was observed. Since this was not due to scattered light, as was proved by the third exposure, it must have been due to resonance radiation from the weakly excited helium

This result appears to prove beyond doubt the possibility of obtaining resonance of the 3889 line in weakly excited helium. A more detailed account of the work will appear shortly.

W H. MCCURDY.

Johns Hopkins University,
Baltimore, Maryland,
December 12.

Allotropy of Chromium.

CHROMIUM prepared by a special method was found to have certain peculiar properties. This fact has led us to make an X-ray examination of the structure of this material, which has revealed the fact that this specimen of chromium was a mixture of two allotropes. Besides a much smaller quantity of the normal body-centred cubic modification, the predominating structure consisted of a form not previously described.

The atoms are arranged on two hexagonal lattices, and form a structure which is almost hexagonal close-packed, the axial ratio c/a being 1·625 instead of 1·633, the ideal ratio for the close-packing of spheres. The distance between neighbouring atomic centres is 2·714 and 2·705 Å U. Below are tabulated the readings obtained from the film and those calculated for a structure of the above type:

Radiation.	Interplanar Spacings in Angstroms.		Reflecting Planes.	Intensity of Lines.
	Observed.	Calc		
β	2·204	...	0002	Very weak.
α	2·346	2·331	$10\bar{1}0$	Weak
β	2·064	...	$10\bar{1}1$	Weak.
α	2·202	2·203	0002	Medium.
α	2·068	2·074	$10\bar{1}1$	Very strong.
α	2·034	...	(110) [1]	Medium.
α	1·608	1·608	$10\bar{1}2$	Very weak.
α	1·358	1·357	$11\bar{2}0$	Weak
α	1·248	1·246	$10\bar{1}3$	Medium.
α	1·177	1·175	$20\bar{2}0$	Strong.

[1] This corresponds with the (110) spacing of the body-centred variety of chromium.

Further work on this subject is in hand to determine the conditions under which the two allotropes are formed.

The X-ray examination was undertaken by us at the Physical Laboratories of the University of Manchester, by the kindness of Prof. W. L. Bragg.

A. J. BRADLEY.
E. F. OLLARD.

Research Department,
Metropolitan-Vickers Electrical Co., Ltd.,
Trafford Park, Manchester, December 18.

X-rays in Industry.[1]

By Dr. G. W. C. Kaye, O.B.E.

THERE are few more stimulating pages in the history of scientific endeavour than those which record progress in the field of X-ray investigation and application.

Physical research has spread itself over 60 octaves or more of electromagnetic waves which are now known to stretch without break from wireless waves 25 miles or more in length through heat waves, visible light waves, ultra-violet waves, and X-rays to gamma-rays of wave-lengths of the order of a ten-thousand-millionth of an inch. In this gigantic gamut of natural activity that group of radiations encroaching into and extending some thirteen octaves beyond the ultra-violet, and possessing wave-lengths ranging from about 5×10^{-6} to 5×10^{-10} cm., is now generally styled X-rays. Of these thirteen octaves, ten are extremely absorbable, but the remaining three possess those remarkable powers of penetrating matter which made Röntgen's discovery so arresting and monumental when it was announced exactly thirty years ago. If we include the gamma-rays of radium, this gives us a total of nearly six octaves of radiation with which the science of medical and technical radiology of the present day does its work.

The differential absorption of X-rays by matter of different densities (which makes the work of the medical radiologist possible), and the diffraction of X-rays, are phenomena which have been turned to account in the industries and arts in a diversity of directions. At the outset mention should be made of the dangers arising from X-rays. These are well known and have caused many casualties in the past. They can, however, be wholly avoided by common-sense protective measures which consist in the main of interposing lead sheet or the like, properly disposed and sufficiently thick, between the X-ray tube and the operator. The reports of the X-ray and Radium Protection Committee should be consulted for details by which complete safeguards can be secured.

RADIOGRAPHY.

One other practical precaution arises in industrial radiography, and that is the necessity for taking account of the scattering of the X-rays. Three things may happen to a beam of X-rays when it passes through a material. Part of it emerges undisturbed and undeviated, and outlines the shadow picture on the photographic plate. Part of it is absorbed with the liberation of characteristic X-rays and electrons. The rest is scattered or dispersed, which is equivalent to stating that, while the rays are not altered in quality or but slightly so, a considerable proportion of them have their direction altered to a greater or less extent. In some cases it is estimated that, of the energy received at a point well within or beyond a mass of material, the fraction arriving by devious routes may be equal to or several times greater than that by the direct route. This proportion may be lessened by narrowing the width of the beam of incident rays, but the size of the aperture is usually prescribed by the size of the object and, in general, the X-ray beam does not approximate to a pencil. Scattering thus produces a sort of halation or fogging of the main image on the photographic plate. The effect may be troublesome enough, even with lesser thicknesses, to impair definition in the absence of suitable precautions, but increases to such an extent with greater thicknesses as to render the method nugatory or nearly so.

Many of the various applications of radiography to industry have come about owing to the fact that the method does not injure the specimen in any way. Further, it provides in many cases the only means, independent of human judgment, of detecting concealed defects in a material or of scrutinising in a structure or sealed enclosure the disposition of component parts which are hidden from view. Incidentally, the mere existence of the method is not without its moral value as regards workmanship. Radiography is, of course, inoperable in those cases where the shape of the object prevents the right disposition of X-ray tube and film.

The X-rays found little effective scope in industry until the invention of the Coolidge tube, which permitted the utilisation of high voltages with standardised procedure. Experience differs as to the sensitiveness of the method, but, depending on the area of the inclusion, probably a variation in density equivalent to 2 to 5 per cent. of the thickness is necessary to be detected on the photographic plate. These figures require to be increased for fluoroscopy, but much depends on the luminosity and on the visual acuity of the observer. Definition is, of course, dependent, among other things, on the size of the focal spot in the X-ray tube. If a body has tapering edges, this will normally result in a nebulous radiographic outline. Exposures naturally depend on the conditions, and may vary from a few seconds to an hour or more. Stereoscopic radiography is sometimes useful in estimating depth.

If the intrinsic value of a specimen is low, or if "mass inspection" is contemplated, then visual inspection with a fluorescent screen is the only practical policy. It is not always satisfactory, but the more expensive and protracted process of photography has to be justified by the value of the specimen, or the importance of the job for which it is intended, or the desirability of confirming the fluoroscopic diagnosis by a permanent record. For some industrial purposes Dauvillier employs an exploring ionisation chamber filled with xenon, the ionisation currents being readily measured by a galvanometer.

The shape of the specimen may be such as to emphasise the evils of scattered radiation. If the object is continuous, with one side flat, there is no difficulty; for the flat side can be brought into close contact with the photographic plate. The same end can be achieved with bodies of regular shape, such as cylinders or spheres, by resting them in closely fitting solid metal "cradles" with flat bases. If the body is irregular in contour, something may be done by filling up pockets or hollows with wax or plasticene and placing a "mask" of lead or lead powder round the specimen. With hollow bodies a film may sometimes be placed inside and sprung against the interior face, though parallax is often exaggerated. In all cases the photographic plate or film should be backed and framed with lead foil.

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[1] From a public lecture delivered at the University of Leeds, November 30.

It should be realised that, while X-rays have proved of considerable value in many directions, their use in radiographing steel is limited at present. While both in Great Britain and America X-rays have been detected photographically after passing through 4 inches of steel, the result has little or no practical value. The present practicable limit is more nearly 2 inches for photography and less than half an inch for fluoroscopy. Incidentally, the corresponding limit for solid masonry is about a foot.

The quality or mean wave-length of the X-rays used depends on the requirements. For very transparent objects X-rays excited by fifty thousand volts or less may suffice. For the more opaque materials we require rays excited by up to 200,000 volts, which is as near to the present upper limit as any present-day X-ray tube will stand. Approximately double this voltage will be required to test so much as 6 inches of steel. The electrical engineer can, of course, generate such voltages, but an X-ray tube has yet to be designed which is capable of turning them to account. The task is not proving easy of solution, and the fact has a bearing on the possible extension of radiometallography to heavy engineering. With such high voltages the scattering effect may be somewhat reduced, and the attendant dangers could doubtless be countered if the results warranted the expense.

Within its limitations, however, radiography is very sensitive; for example, fine tool or mould marks and similar surface irregularities are frequently displayed in radiographs. Blowholes in castings show up as light spots. Cracks are occasionally revealed, though, if they are filled with material of density not very different from its surroundings, or if the cracks are fine or tortuous (hair cracks), the method normally fails. A negative result does not, in fact, afford a positive answer. Inclusions of sand, etc., are registered as cloudy, indefinite areas. The method has been proved to be of value in suitable cases for checking up steel castings and so preventing the machining of defective castings.

If the specimen is of large area, such as a turbine disc, to radiograph the whole disc is a costly and protracted operation which has, however, on occasion been carried out in its entirety in Great Britain. But normally in such cases the X-ray method would be used only when the material is already under suspicion by the use of other tests.

X-ray photography of steel welds has been used successfully for thicknesses up to about 1 inch. Welding is discredited for some purposes, for it is easy to scamp such work, but the X-rays are a somewhat severe critic in displaying blisters, blowholes, and lack of bonding. Skilled experience can usually say whether any imperfections indicated in the radiograph are sufficiently serious to disqualify a weld for its purpose. The method will not, however, indicate a common defect of welding—the burning of the adjacent metal.

The X-rays have become a useful adjunct in the photography of a variety of subjects in the laboratory and in the industries. The manufacturers of electrical insulators—ebonite, built-up mica, fibre, paper—find the X-rays useful for detecting the presence of metallic particles, particularly if a high-grade product is desired. Fibre is frequently made from pulped rags and so may contain foreign metallic matter. Feminine labour has been occasionally responsible for the presence of hairpins in the finished product.

The centrality of the core of a heavily insulated electric cable can be tested by this means. In such a case as this, to secure both a sharp outline of the opaque core as well as clear detail of the more transparent insulation, a good plan is to make the exposure partly at a high exciting voltage and partly at a low voltage. The soundness of steel balls intended for ball bearings; the differentiation of lead-glass from soda-glass stems of clinical thermometers—now a routine test at the National Physical Laboratory—the centrality of the cores of golf balls; the test of the fit of a new shoe on the foot as now met with in many shoe shops; the nature of certain defects in artificial teeth; the proportion of ash in samples of coal, are among recent examples of the use of the method.

Aircraft materials afford scope for the X-rays as a testing agent. Aluminium alloys are very transparent, and so lend themselves to radiography, while if steel is used, its greater trustworthiness is offset by the necessity of keeping the weight down. The main difficulty, in fact, with aircraft components is usually their shape rather than their thickness. Timber offers no difficulty, of course, and the use of X-rays in this connexion, more particularly as regards aeroplane parts, was demonstrated during the War.

If a material is very transparent, its opacity may sometimes be increased much as a medical radiologist uses bismuth meals to watch processes in the alimentary canal. For example, the Dunlop Research Laboratory, by previously impregnating selected canvas threads with lead chromate, was able to test whether the stretch during the successive processes of manufacture of a tyre was within the limits tolerated by the yarn. Similarly, if it is desired to watch the behaviour of glued joints or splices while under stress, the radiography is facilitated if a little lead salt is added to the glue.

X-ray photography is at times particularly useful for displaying the construction of apparatus, the interior of which is hidden from view by thin metal or other opaque container. Among examples which may be cited are the counting of the turns of wire in a coil heavily covered with insulation; the details of the design of opaque vacuum pumps and radio valves; the interior detail of opal-glass electric lamps; the construction of selenium cells; the internal diameter of metallic tubing; and the interior construction and accuracy of assembly of explosive devices—this last by the Research Department at Woolwich Arsenal.

In quite another direction radiographs recently taken in Chicago of Egyptian and Peruvian mummies showed that rickets, bony tumours, pyorrhœa, caries of the teeth, were common conditions of disease, as nowadays. It was further found possible to gather something definite about the age and sex, and the nature of any injuries received. A recent attempt to X-ray the mummy of Tutankhamen was nullified mainly by the heavy gold "armouring" of the body.

Finally, one other application of radiography may be referred to. As is well known, the forging of valuable pictures and antiques has always been a flourishing industry. One estimate puts the number of Rembrandts in existence at four to five thousand, yet, so far as is known, Rembrandt painted about 700 in his lifetime. We know that Sheraton had a little shop and did most of his work himself with only occasional help from a few expert artisans, but the amount of Sheraton furniture in existence belies the truth of this.

The X-rays have shown that they can sometimes usefully supplement the tests which are commonly resorted to for detecting fraud in old Masters and antiques. A radiograph will sometimes reveal constructional or other detail sadly out of tune with the reputed period. In the case of pictures or panels, the X-rays may give instructive information on the pigments which, in general, are more opaque in old pictures than in new, on the priming, which is commonly more opaque in new pictures than in old, and on the canvas, wood, or other surface painted on. Thus it happens that in the case of an old painting the X-rays can sometimes be employed as a means of detecting alterations or restorations or of identifying a modern fake.

Radiography could similarly be used to establish the identity of originals of modern pictures or panels, forgers of which are therefore not prevented from simulating closely the canvas, wood, and pigments. But in a radiograph the fine details of the canvas, or of grain and knots in the case of wood, are so characteristic as to be impossible of exact copying. If such records were normally taken, the method would also be of service in differentiating between the original and the copies painted by the artist himself. Furthermore, tentative detail ultimately painted out is sometimes revealed in the original painting which naturally is not repeated in the copies.

X-RAY DIFFRACTION

From Laue's momentous discovery in 1912 of the diffraction of X-rays, the science of X-ray spectrometry has grown to great proportions. The main developments deal with emission and absorption spectra, with crystal analysis and with the structure of atoms. Naturally, with the growth of the subject, special apparatus and technique have been developed.

In optical spectra the number of lines peculiar to an element are frequently numerous and their numerical relations complicated. X-ray spectra, on the contrary, are noteworthy for their simplicity, the number of lines characterising an element being relatively few, readily recognisable, and measurable with a precision not inferior to that which obtains in optical spectra. Moseley's great discovery in 1913 established a simple proportionality between the atomic number of an element and the square root of the frequency of a characteristic radiation or of an absorption limit. Moseley's law holds for all the known elements, and so it is possible to interpret new spectral lines with ease. It was by X-ray spectrometry that the element hafnium was discovered in 1923; and only recently Nonnack and Tacke announced the discovery by X-ray analysis of two new elements which they called masurium and rhenium. Thus 89 out of 92 elements are now known, and the spectral lines of the missing three elements (Nos. 61, 85, 87) are predictable with certainty.

X-ray absorption spectra are very simply obtained by passing a pencil of X-rays through a sample of the matter and examining the transmitted beam by a crystal spectrometer. The X-rays should be excited by a suitably high voltage. It is best to have the substance in finely powdered form deposited on, say, paper. Very little material will suffice if the absorbing screen is placed at the slit of the "collimator." Solutions can also be tested, though not so readily. The method is specially applicable to all elements with a strong *K* absorption band, *i.e.* the iron group and heavier elements. For the elements of high atomic number the *L* band is also convenient. In the case of mixtures of adjacent elements the several absorption bands may tend to obscure one another, and for this reason the method excels in detecting traces of heavy elements in light elements.

Emission spectra are conveniently excited by mounting the material on the face of the target of an X-ray bulb and applying a suitably high voltage. In such spectra every element present is recorded with an intensity which depends only on its concentration and is independent of the presence of any other elements with which it may be mixed or combined. Such intensities are measured with a microphotometer. The method thus enjoys great advantages over optical spectroscopy. The test is a very sensitive one and, although not suitable for the very light elements, has found commercial application in analysis of the platinum group of metals and the rare earths. An alternative method, though not so effective, is to bombard the test material with X-rays, as in Barkla's original method of exciting characteristic X-rays. This can be readily made the basis of a method for analysing mineral salts.

The aim of X-ray crystal analysis is to determine the grouping of the atoms and molecules in the crystal unit, and so to account for the properties of the crystal. There are three main experimental methods:

(*a*) Laue's method, in which a narrow pencil of heterogeneous rays is passed through a single crystal.

(*b*) The Hull-Debye-Scherrer method, where homogeneous rays are passed through a thin rod of crystalline powder.

(*c*) The Bragg spectrometer method, in which a "slit" of homogeneous rays is reflected from a single crystal.

Many variations in the technique of these methods have been developed, some of which are becoming of industrial importance. For example, the Laue method may be arranged to test the general orientation or symmetry of crystal aggregates, in which case homogeneous rays are advantageous. The Bragg method is also applicable to a conglomeration of minute crystals. In many of these methods the specimen is kept in continual rotation or oscillation (de Broglie).

Our knowledge of the atomic structure of the solid state of matter owes more to X-ray analysis than to any other means. For example, most chemical elements, including solidified gases, have been shown to crystallise in the cubic or hexagonal system. Already nearly half the elements have been examined, including those allotropes which can arrange themselves in more than one kind of space lattice. As regards alloys—solid solutions and intermetallic compounds—the

X-rays have thrown light on and tested the truth of the existence of the several phases of steel and other alloys which metallurgists had differentiated by other means. The method has also indicated the atomic features which go hand in hand with ductility, hardness, etc. It has also been shown that in a solid solution of two elements the replacement of one atom by another is effected by substitution in and distortion of the lattice and not by interstitial insertion (Owen and Preston at the National Physical Laboratory). Other points which have been worked on are the effect of annealing, tempering, rolling, or other working; the mechanism of deformation and slip in metals; and the general shapes and sizes of atomic domains.

By the use of X-rays Sir William Bragg has shown that a diamond has an atomic bonding perfect in its symmetry and so possessing intense hardness. On the other hand, graphite (another variety of carbon) with unsymmetrical atomic linking, with weak linking and greatest separation between cleavage planes, is a good lubricant. So-called amorphous carbon is found to consist of minute graphite crystals. The fragility of annealed tungsten lamp filaments is explained by the gradual transformation to a number of single crystals of large dimensions.

The X-rays have demonstrated that almost every solid substance in Nature shows crystalline form, including such apparently amorphous materials as rubber, cellulose, soap, leather, bamboo, and talc. Müller and Shearer have shown that the fatty acids give characteristic spectra which enable them to be identified in mixtures. This work was done at the Davy Faraday Laboratory where, under Sir William Bragg's guidance, the structures of many organic and inorganic crystals have been elucidated. Colloidal metals are shown to be made up of minute yet perfect crystals so small that they contain only a few score atoms. The molecular arrangements in thin metal and liquid films have been ascertained. In gold leaf, for example, the cubic crystals are found to have their cube faces parallel to the sheet. The Laue method has been used at the National Physical Laboratory to ascertain the crystal axes of jewel bearings. Within the last few months Dauvillier and Shaxby have ascertained the structure of pearls and shown that the Laue method, using homogeneous rays, affords a trustworthy and valuable criterion between the true natural pearl and the cultivated Japanese pearl, consisting of a thin pearly covering on a sphere of mother-of-pearl as a nucleus.

These are but a few of many examples which indicate that the several processes of X-ray spectroscopy are not only a valuable scientific tool for the physicist, but also that they are destined to play an important rôle in many industrial processes of the future. There are grounds for hoping that light may be thrown on the mechanism of such properties as magnetism, electrical and thermal conductivity, contact and thermal electromotive forces, dielectric capacity, fluorescence, the various types of elasticity, cohesion, diffusion, adsorption, etc.

Mineral Industries of the United States during the War.

THE mineral resources of the United States are of primary importance, for in 1915 that country produced 40 per cent. of the world's output of coal, 40 per cent. of its iron ore, 32 per cent. of its lead and zinc, 60 per cent. of its copper, and 66 per cent. of its petroleum. Since then, some of these proportions have increased. The data for the history of the mineral development of the United States during the War have now been issued in seven thick volumes,[1] which contain for each year the full record of the United States output of all important economic minerals, with shorter accounts of the contributions of other countries. The volumes consist mainly of compilations of mineral statistics accompanied by the statement of such geological and economic facts as are necessary to their interpretation. In each volume some chapters, in addition to the annual statistics and record of the year's development, contain a general review of the subject with reference to the current literature and geological descriptions of the chief mining fields. These monographic chapters include those on chromite by J. S. Diller, on graphite, with interesting accounts of its mining in Ceylon and Madagascar, by H. G. Ferguson, on molybdenum by F. L. Hess, on potash by W. B. Hicks, on American utilisation of peat by C. C. Osbon, and on quicksilver by F. L. Ransome. In view of the importance and variety of the American yields, the especially important sections are those dealing with coal, petroleum, and the five metals which are so closely associated that they are recorded together—gold, silver, lead, copper, and zinc.

We find in these volumes, in addition to the record of the normal development of the mining industry, an account of the more sensational temporary effects of the War, which were often bewilderingly unexpected and contrary. Prices rose and fell in a manner that was at the time inexplicable, and in some cases is still obscure. The answer may be simple, though not obvious at the time; thus, although cadmium is more expensive than tin it was used in solders as a substitute, so that tin might be reserved for purposes for which it was indispensable. Some of the uses to which cadmium was put are still unrevealed, and Mr. Siebenthal, the author of the chapters on that metal, reports that a German firm in 1913 advertised for the purchase of unlimited supplies, and refused to answer inquiries as to the purpose for which it was wanted. It was certainly used in Germany during the War as a substitute for tin, but other uses by the belligerents on both sides have not yet been revealed.

The War, by its increased demands for metals, helped some branches of mining, but hampered others; thus the unlucky antimony miners of China, who produce the bulk of the world's supply, suffered both from the fall in price of their product and from the rise in the price of silver, which added to their working costs. In the case of some metals a fall in prices appeared to encourage production. This anomaly is now explained by the feverish prospecting in consequence of the sudden increase in the demand. Thus in the zinc fields of Oklahoma it is estimated that ten years prospecting work was done in two years; and ore had to be produced and sold at any cost to repay the expensive development work, and thus the mines had to empty their reserves during the subsequent slump in prices. The anxiety as to the shortage of molybdenum in the early part of the War was easily allayed by the United States, where it was known to occur in many districts; the chief producer had been Arizona, but the demand was satisfied by the output from the colossal deposits of fractured granite yielding about 0·8 per cent. of molybdenite at Bartlett Mountain near Leadville, Colorado.

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[1] Dept. of the Interior, United States Geol. Survey. Mineral Resources of the United States:
1915. Part I., Metals, 1917, iv, 99a, 1000+3 pl.
1916. Part I., Metals, 1919, v, 73a, 871+3 pl.
1916. Part II., Non-Metals, 1919, v, 1115+4 pl.
1917. Part I., Metals, 1921, v, 79a, 980+8 pl.
1917. Part II., Non-metals, 1920, vi, 1293+1 pl.
1918. Part I., Metals, 1921, iv, 149a, 1096+9 pl.
1918. Part II., Non-metals, 1921, viii, 1557+16 pl.
Washington: Government Printing Office.

In spite of the War troubles, many of the American mining fields continued their normal progress. Thus the goldfields of California, in spite of seventy years of production, still have mines working in five of the counties along the great Mother Lode; in 1918 they yielded no less than 1,015,509 short tons of gold ore of a value of 4,334,061 dollars, or an average of 4·268 dollars per ton. The total yield was smaller owing to the War conditions and not to the exhaustion of the ore, and some of the mines that closed down are expected to reopen when costs become normal. The placer mines of California are worked successfully both by hydraulic sluicing and dredging, and it would be of interest if the yield per cubic yard and costs of working were stated. For Alaska these figures are given, showing that the dredges are working there at the high cost of about 2*s.* 6*d.* per cubic yard; the amount fell owing to the higher costs. Of the Alaskan placers 574 of them were at work during the summer and 153 in the winter; but the lode mining is increasing and in 1918 yielded 29 per cent. of the output. The great Homestake Lode of South Dakota, famous for the large scale of its operations, has still vast reserves of ore. Between 1875 and 1918 it has yielded 160 million dollars of gold with a profit of 41 million dollars. The output of ore in 1918 was 1,628,000 tons, but the dividends, owing to higher costs, fell one and a half million dollars.

The United States still maintains its supremacy in copper production, and on opening these volumes it is natural to turn at once to the sections which show the conditions at the Calumet and Hecla Mines of Lake Superior. They work three "lodes," as they are called to satisfy American mining law. The famous conglomerate which was the most remarkable ore from this field is nearly exhausted; the working of the amygdaloids is increasing, and the mines obtained 67 million pounds of copper during the year 1918, at a total cost of 21·65 cents per lb. The prolific field of Butte, which, mainly from one mine, the Anaconda, for years supplied 60 per cent. of the world's output of copper, has had in recent years a less prosperous time owing to the competition of large bodies of low-grade ore in the south-western States; but the yield from Butte in 1918 was still more than 313 million lb. of copper ore worth nearly 80 million dollars, in spite of the fall in price of the metal from the previous year. An especially interesting development announced is the reopening of the lower levels of the famous Comstock Lode in Nevada. Their closing thirty years ago by floods of superheated water is one of the best known and most instructive tragedies in the history of mining. The water has now been lowered by electric pumps through the Sutro Tunnel, world famous for its evidence as to the geology of the Comstock Lode; and good ore has been worked at 2900 ft., and some ore found at the depth of 3100 ft.

Tin remains the one metal in which the United States output is practically negligible. In 1918, in spite of the search for tin stimulated by its high price, the output amounted only to 69 short tons, mostly yielded by the gravels of Alaska with a little from South Dakota and Carolina. The report on tin is illustrated by one of the many interesting maps showing the distribution of mining through the world; but this map appears to suggest that the Australian output of tin is in New South Wales, and the figure should have been over Tasmania.

Amongst the non-metallic materials, the normal development has continued the remarkable increase in American cement production, which is now nearly all of Portland cement. A peat industry has been established in recent years; its delay was no doubt due to the abundance of coal. The peat deposits of the United States are widespread through the north-eastern and north-central States from Minnesota to Maine, and the oft-expressed belief that peat cannot be formed in the tropics is contradicted by the large supplies known in Florida and beside the Gulf of Mexico. The bulk of the peat in the United States would appear to be a result of glacial conditions, and it is attributed to accumulation in the lakes, pools, and marshes left by the last glaciation. Peat is used mainly in the States for the manufacture of bacterial fertilisers, and as litter owing to its power of absorbing stable fluids; but in 1918, owing to the higher price of coal and difficulties of transport, it was used as fuel for the first time on an important scale in parts of the United States.

One of the most interesting developments of the non-metallic minerals during the War was that of potash. The agriculture of the eastern States of America was largely dependent on German supplies, and on their complete stoppage desperate efforts were made to utilise the local sources. It was found, however, that potash is not so indispensable as had been thought, and the view has since been expressed that the American farmers' faith in potash was a delusion inspired by the persuasive salesmen of the German Potash Syndicate. The urgent supplies of American potash were yielded by the Salt Lakes of western Nebraska; but it is recognised that they cannot be worked at post-War prices. The development of Searles Lake in California has been watched in Great Britain with especial interest; but the reports up to 1918 are of continued disappointments owing to technical and legal difficulties, which, it is said, are at length overcome and ultimate success there is anticipated. Some American igneous rocks contain huge quantities of potash silicates, but it seems doubtful whether they can be worked profitably in competition with the German supplies. The volume for 1918 enumerates many patents for the extraction of potassium from silicates; but these are not now regarded as hopeful, as the fall in price after the renewal of supplies from Germany led to a collapse in American production, and the closing of most of the potash mines.

Coal is dealt with at great length for each year, and the report condemns what it describes as the utterly wasteful methods of American coal mining. The chapters on petroleum record the intense activity of the period under review, which afterwards had a disastrous effect on the American industry. The efforts of 1918 are now ancient history in the swiftly changing conditions of the mineral oil industry, and it is interesting to read the predictions of 1918 with the information of six years later. It is remarked with satisfaction that the oil yield had been maintained in spite of the inherent difficulty of finding new pools, and it is suggested that California, after six years' production at its peak, must be prepared for a decline. The great success of the year 1918, in consequence of the active drilling, was in Texas; but that achievement was soon surpassed by the enormous increase from California, which produced a revolution in the American oil trade. In the report on 1915–16, confidence was expressed in the quick development of the oil shale of Colorado, but apparently nothing is said about that material in the later volumes, and the American output of shale oil was only begun in subsequent years.

By their wealth of compressed information and by the varied interest of the problems elucidated, these reports maintain the high standard which has made the series one of the chief works of reference in the history of the mineral industries of the world. J. W. G.

Solar Eclipses and the Eclipse of January 14, 1926.

THE rarity and striking character of total eclipses of the sun naturally predisposes astronomers to their study. Eclipses have revealed a remarkable feature in the movement of the moon, and successive observations are year by year increasing our knowledge of the sun's surface and surroundings. In the eighteenth century Halley, from the study of records of early eclipses, inferred a secular acceleration in the moon's motion. Twenty years ago Cowell confirmed this, and discovered a small secular acceleration of the sun's motion. His results have been further verified and amplified by Fotheringham. It has been shown by Taylor and Jeffreys that these results can be quantitatively explained by a slowing of the earth's rotation caused by the friction of the tides in certain shallow and constricted seas.

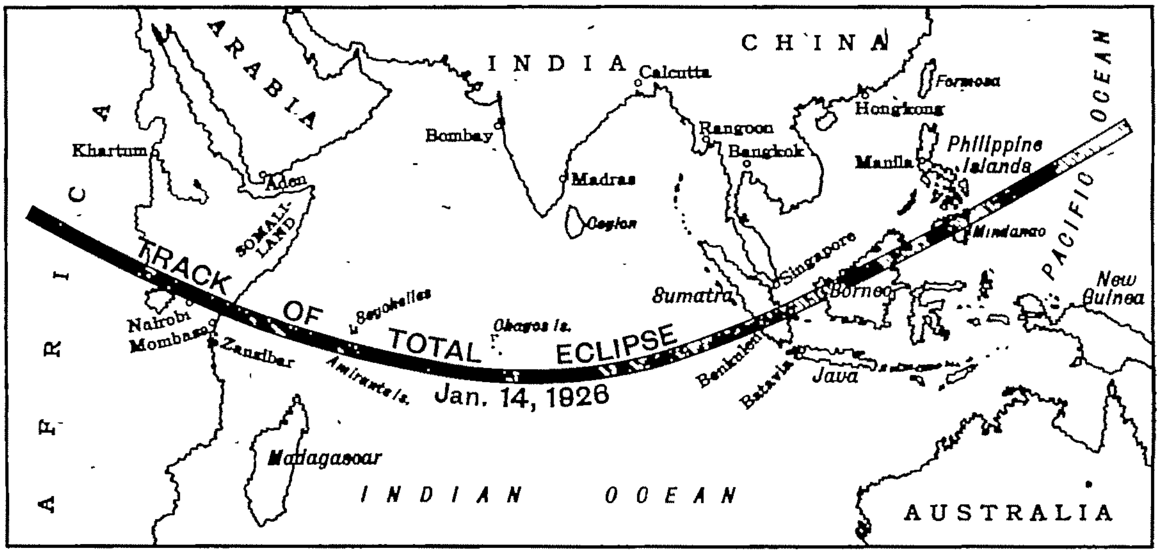
The observations of eclipses in the earlier part of the nineteenth century showed that the corona as well as the prominences belonged to the sun itself, and that it was not a halo produced in some way by the earth's atmosphere. The eclipse of 1868 led to the simultaneous discovery by Janssen and Lockyer of a method of observing prominences without an eclipse, and was a first stage towards the development of the spectro-heliograph. At the eclipse of 1870 Young, watching the diminishing crescent of the sun through his spectroscope, observed the reversal of the dark lines of the spectrum at the moment the eclipse became total. The existence of a green line in the spectrum of the corona near the iron line 1474*K* was also discovered. In course of time it was found that this line could not be attributed to any known element, and the name coronium was given to the substance from which it emanated.

Since this time the most important observations at eclipses have been made by photography. They have confirmed the fact, already shown by drawings, that the form of the corona changes in sympathy with the well-known cycle of the sun's activity shown by spots and prominences. But the main purpose of modern eclipse observations has been the elucidation by means of the spectroscope of the nature of the sun's surface and of the corona. One important exception is the verification of the bending of a star's light in passing through the sun's gravitational field, predicted by Einstein. British observers, taking advantage of the neighbourhood of seven bright stars in the eclipse of 1919, found that these stars showed, severally, displacements in accordance with the generalised theory of relativity. The result was confirmed in a more statistical manner by the American astronomers at the eclipse of 1922.

A great advance in the study of the constitution of the sun's surface as revealed at the instant at which the eclipse becomes total was made by Lockyer and Fowler in 1893. They found that the "flash" spectrum, as it is called, was not a mere reversal of the solar spectrum, but that many lines were "enhanced" in brightness, corresponding to differences found in the laboratory between spectra of the same substance obtained from an arc and from a spark. They amplified this by observations at the eclipse of 1898, and the striking differences between the "flash" spectrum and the permanent spectrum have been verified over a greater range of spectrum and in more detail at subsequent eclipses. These differences are now known to arise from ionisation of the elements, and Saha has shown what light they throw on the pressure and temperature at different levels above the sun's photosphere. In this connexion, the accurate determination of the heights above the photosphere which different elements attain is of importance. These heights have been determined from the lengths of the arcs of the "flash" spectra obtained by the use of an objective prism, but further research is needed.

These partially solved problems, combined with the desire to witness a very striking phenomenon, attracted a large number of astronomers from different countries to observe the eclipse of January 14, 1926. The track ran from the east coast of Africa across Sumatra to the Philippines (Fig. 1), and the maximum duration of the total phase was a little more than four minutes. An Italian expedition, under Dr. Horn d'Arturo, went to Somaliland. The British, French, German, Dutch, Australian, and several American expeditions chose sites in Sumatra, generally near Benkulen on the west coast, or the more readily accessible Palembang on the east coast. The telegraphic reports show different degrees of good fortune in the weather. The distribution of observers ensured good photographs of the corona. This is satisfactory, as in view of the relationship between the form of the corona and the phase of the solar cycle it is desirable that such photographs should be secured at all the rare opportunities furnished by eclipses. It would seem that cirrus cloud has probably interfered with the further verification of the Einstein deflexion of light. To some this observation may appear a work of supererogation, but as an experimental problem it is very attractive, as by the photography of a field of stars a few degrees from the sun as well as that of the eclipsed sun, the agreement with theory can be more closely verified.

The British expedition near Benkulen was fortunate in weather and carried out its programme completely, but it is impossible as yet to say what results were obtained. The observers attempted to obtain spectra of the "flash" and the corona so far as possible in the infra-red and ultra-violet parts of the spectrum, where further exploration is required. One of their aims was to obtain the relative intensity of different lines of the spectrum of the chromosphere. In particular they wished to compare the intensities of two calcium lines in the extreme infra-red with *H* and *K*, as Prof. E. A. Milne had pointed out the special value of this observation in the determination of the degree of ionisation near the sun's surface. Photographs of the corona and of its spectrum, and the precise determination of the beginning and end of totality from the appearance of the "flash" lines, were also included in their programme.



Emery Walker Ltd sc.

FIG. 1.—The track of the solar eclipse of January 14, 1926.

To show what is involved in the observation of an eclipse, a more detailed account may be given of the British Expedition. In 1914 the Joint Permanent Eclipse Committee of the Royal and Royal Astronomical Societies decided that an expedition should if possible be sent to observe the eclipse of January 14 last, and it also prescribed the general lines of the research to be carried out. The Committee invited two of its number, Col. Stratton and Mr. Davidson, to undertake the task. These gentlemen had then to frame provisional estimates of the cost, so that a grant could be applied for from the Government Grant Committee of the Royal Society. When this was assured they had to decide upon the most suitable site in consultation with the Meteorological Office and the Admiralty. Their next task was to settle in detail the programme of observations, and to set about securing the best available instruments. They obtained a number of cœlostats from the Eclipse Committee, and borrowed other instruments from all sources. The Edinburgh Observatory lent a 4-inch lens of 40-ft. focus, formerly used by Dr. Copeland with a long iron trellis-work tube which could be taken to pieces and put together on the spot. The Royal Irish Academy lent a 4-inch lens of 20-ft. focus, and for a tube they adapted one made in sections and used by Greenwich observers in 1919. The Solar Physics Observatory at Cambridge lent two spectroscopes (one flint and one quartz) given to the Observatory by Col. Hills and used in several previous eclipses. In addition several prisms and speculum mirrors were collected. Other instruments, including a cinematograph, were bought by Mr. Barton, who arranged to go with the expedition as a volunteer to determine the precise instants of the commencements and end of totality. A wireless installation was kindly lent by Messrs. Burndept, Ltd., for the reception of time signals, and a recording chronometer by M. Dittisheim. The various instruments were then set up and got into approximate adjustment. Clocks were cleaned and repaired, mirrors silvered, and photographic plates and chemicals obtained. Observing huts of light wooden frames covered by waterproof canvas were constructed, the instruments and baggage were carefully packed and despatched to Liverpool for conveyance to Sumatra, the Blue Funnel Line kindly accepting this four tons as passengers luggage without extra charge.

The three observers sailed from Liverpool on November 7, and reached Benkulen, *via* Singapore and Palembang, safely with their instruments on

December 14, just a month before the eclipse. They thus had sufficient, but not too much, time to get their instruments erected and adjusted. They were joined later by Dr. Aston and Col. J. Waley Cohen, who combined a view of the eclipse with service to the party in the manipulation of their half-dozen instruments during the four minutes of totality. After the eclipse the plates must be developed, brought home and measured before the value of the results of half a year's work can be assessed. The observation of eclipses is expensive in time and money. The return on the outlay has been hitherto highly satisfactory, and we may expect that equal success will attend the latest expedition. F. W. D.

Obituary.

MR. ALFRED BELL.

MR. ALFRED BELL, who died at Ipswich on December 7, 1925, was born in the parish of St. Marylebone on June 28, 1835. During his long life of more than ninety years, he had been brought into contact with a long succession of geologists, and he was personally known to Murchison, Sedgwick, Lyell, Owen and many others. His interest in science was awakened in early years by reading illustrated popular literature, and he became a collector, with his brother Robert, a year or two older than himself, at the age of about eleven years. Robert, who also specialised in conchology, was a well-known authority on this subject. Alfred, whose interests were at first more general, obtained specimens in any way he could, partly from sailors returning from abroad, and among his personal efforts may be mentioned the collection of fossils he made from the cuttings of the Great Northern Railway, then in process of construction out of London.

Largely a self-taught geologist, Alfred Bell's education in the science began with a course of lectures he attended at a Working Men's Institute. By 1868 he had made sufficient progress to publish, in conjunction with his brother Robert, an account of the Mollusca of the Red Crag; and, somewhat later, another paper which resulted in making the acquaintance of Searles V. Wood, who was then making preparations for a supplement to his "Crag Mollusca." Robert died in 1888, and Alfred continued the work begun by his brother, with Prof. Kendall, on the newly discovered Pliocene beds of St. Erth, Cornwall. To the end of his life he worked specially at the East Anglian Crag, of which he had a remarkable knowledge. He visited all the important Pliocene deposits of Great Britain, Ireland and the Isle of Man, and he had some personal knowledge of those of Holland, Belgium and the Rhine Valley. His judgment on the specific differences of molluscan shells was regarded as particularly good, and a long list of papers on this group stands to his credit.

Alfred Bell was not one of the favourites of fortune, and he was obliged to make his living in commercial life, partly in the employment of others, but for a time as a professional collector and dealer. In the later years of his life he became the friend of Mr. F. W. Harmer, to whom he made prolonged visits, taking the greatest interest in Harmer's monograph on Pliocene Mollusca, the preparation of which was facilitated by the opportunities given by the visits for discussion and criticism. After Harmer's death, in April 1923, Bell retired to Ipswich, where he worked indefatigably until a few days before his death. His last paper, referring to the shells of the Isle of Man, was in the press when he died.

Without any special educational advantages, Bell acquired a wide knowledge, not only of his own subject, but also of others, such as archæology and history. He was of a genial temperament, possessing a considerable fund of quiet humour, and his characteristic optimism did not desert him even in his closing years, when the disabilities of old age fell heavily on him. His friends speak of him with affectionate regard.

G. MAYNARD.

REV. GEORGE HENSLOW.

THE Rev. Prof. George Henslow passed away at Bournemouth on December 30 last, in his ninety-first year. He was the younger son of Rev. John Stevens Henslow, professor of botany in the University of Cambridge, and afterwards Rector of Hitcham, in Suffolk; his mother was Harriet, a sister of the Rev. Leonard Jenyns, better known as Blomefield, a west country naturalist.

George Henslow was born at Cambridge on March 23, 1835, received his education at Sawston Parsonage, six miles to the south of Cambridge, then at the Grammar School of Bury St. Edmunds, and in 1854 became a scholar of Christ's College, Cambridge. He gained a first class in the Natural Science Tripos, and second class in divinity and mathematics. After graduating in 1858, he was ordained, and became curate of Steyning, Sussex, in 1861 receiving the appointment of headmaster of Hampton Lucy Grammar School, and four years later a similar post in London. In 1886 he became lecturer on botany to St. Bartholomew's Hospital Medical School until 1890, lecturing at other institutions also. He was a popular lecturer at the Royal Horticultural Society for many years; he had a good resonant voice, his method was attractive, his delivery clear and plain, and in the days before lantern-slides were common, at the right moment he would display a specimen or a drawing to his audience

Henslow's pen was busy upon botanical subjects, largely in a popular sense, on evolution, the fertilisation of plants, Bible plants, the origin of flowers, and the like. Some years before his death, he gave to the Linnean Society eleven volumes of reprinted papers and three volumes on Darwinian subjects. He was elected a fellow of this Society on March 17, 1864, and at the time of his death was the senior fellow but two. He was twice married, his second wife surviving, but left no family.

WE regret to announce the following deaths:

Mr. R. A. F. Murray, a pioneer of the Geological Survey of Australia and Government Geologist from 1881 until 1897, aged seventy-nine years.

Prof. W. H. Warren, Challis professor of engineering and president of the Professorial Board in the University of Sydney, and twice president of the Roya Society of New South Wales, aged seventy-three years.

News and Views.

The National Institute of Industrial Psychology announced last week that in response to its appeal for funds, issued by Earl Balfour, an anonymous gift of 10,000*l* had been received. Although the first list of donations has not yet been published, it is known that a thousand guineas have been contributed by Messrs. Debenham's and a hundred guineas by the National Union of Railwaymen. The Institute was established for promoting the study of the human factor in industry and commerce, and applying the results of such study in practice. Its investigations include the study of the best methods of work, especially the elimination of unnecessary movement, the most advantageous distribution of periods of rest and work, and the reduction of monotony. Suitable methods are devised for securing more efficient and scientific selection of workers, and better guidance of adolescents when choosing their life's work. Five years have now passed since the Institute was founded, and investigations have been carried out in twenty-six different industries. Almost invariably the resulting improvements in working conditions and methods have led to increased output accompanied by reduced fatigue, and some indication of the encouraging support and assistance given by both labour and employers is shown by the donors mentioned above. When work for private firms is undertaken, they are required to pay to the Institute a sum covering the expenses of the work, but, as with every other application of science, an enormous amount of preliminary research is essential before the results can be put into practice. The appeal for 100,000*l*. has been issued to form an endowment fund to allow of such research, and to equip a satisfactory laboratory and technical library.

Before the end of the year it is expected that radio communication will be established between all the principal dominions of the British Empire. The stations at Bodmin in Cornwall and at Bridgwater in Somerset, which are on the Marconi short-wave beam system, are practically completed, all the masts being erected and nearly all the radio apparatus is installed. The engineers are only waiting for the conclusion of the tests at Chelmsford on the transmitters and receivers before starting operation. The Bodmin station is the transmitting station with Canada and South Africa, and the Bridgwater station is the receiving station for these services. Each station has ten masts, five for each dominion. The design of the masts is identical at each station. A row of five is erected at right angles to the direction at which signals are received or emitted. The masts are 277 feet high and 650 feet apart. Each mast has a cross arm at the top measuring 90 feet. There are two parallel steel cables, separated by a distance dependent on the wave-length used and running on each side of the masts from the first to the last, a distance of about 3000 feet. Internal combustion engines are used to drive the alternators, and the various requisite voltages are obtained by motor generators. The valves are of the oil cooled type and are mounted in a separate room adjacent to the power house. Owing to the high frequencies employed, the feeders to the aerials are made of copper tubes. Both stations are connected with the London General Post Office, and the transmitting station is operated from London by "distant control." The incoming messages are automatically relayed to London. Both outgoing and incoming messages will be received at the same table in the telegraph office, thus giving true duplex working and complete central control over the traffic. Similar stations are being erected at Grimsby and Skegness for communication with Poona in India and Melbourne in Australia. At the present time Marconi's Wireless Telegraph Co., Ltd., has in hand seventeen short-wave transmitting stations.

A paper entitled "Recent Forestry Development" was read by Mr. W. L. Taylor before the Surveyors' Institution on January 11. Mr. Taylor is a member of the staff of the Forestry Commission and his paper, perhaps naturally, presents the views of that Department of the progress made in afforestation in Great Britain since the passing of the Forestry Bill in 1919 and the inauguration of the Forestry Commission. That considerable progress has been made is undeniable, but professional opinion in Great Britain cannot be termed unanimous as to the wisdom of some of the activities of the Commissioners. During the six years some 52,279 acres of conifers and 2254 acres of hardwoods have been afforested by the Commissioners In addition, as a result of grants in aid made by the Commission, a further 49,695 acres have either been planted, or the area prepared for planting, by public bodies or private individuals. Mr. Taylor states that some bad planting seasons have been experienced during the period, but is silent on the important subject of failures experienced. The remarkable afforestation work proceeding on the catchment areas of some of the big city water schemes such as Thirlmere, Derwent Valley, Vyrnwy, etc., is rightly highly commended. Up to date, the Commissioners have acquired 243,280 acres of land, of which 165,400 acres are considered to be plantable. The land appears to have been acquired at reasonable rates. One or two notable gifts of land have been made by private individuals, and the Crown Woods, Forest of Dean, New Forest, etc., have now been placed under the Commission. The scheme for the establishment of forest workers' holdings, inaugurated in 1924, should have great possibilities before it if correctly worked.

For some time past, the monthly journal *Roads and Road Construction* has been urging the necessity for organised research on road-construction, and in the January issue the question is returned to and it is pointed out, among other things, that research conducted under government auspices need in no way clash with that undertaken in private laboratories. The great problem is stated to be that of making a road capable of carrying the ever-increasing bulk of traffic and axle-weight, without having to lay down a road-crust so massive that the expense would be prohibitive. Although rural roads in Great Britain are not above suspicion, those in the United States appear to be worse; no less than 85 per cent. of them, it is stated, are nothing more than tracks and are impassable for several months in the year. Very satisfactory results have recently been obtained in North Carolina, where the sands extend for hundreds of miles along the coast, by mixing 93 per cent. of sand with 7 per cent. of bitumen, and the view is expressed that much more sand should be used for road-construction in Great Britain. To the same issue Dr. P E. Spielmann contributes an article in which he deplores the paucity of research-work on road-construction. Apart from the routine-testing of materials, the National Physical Laboratory has shelved its research work on behalf of the Ministry of Transport, and the various incorporated bodies having interests in this direction appear to be equally passive. Attention is directed to the plan of the Worshipful Company of Paviors to create a Maybury chair of highway engineering, tenable in the University of London, and the hope is expressed that research problems of basic importance will be undertaken by some government organisation appointed for the purpose.

THE report of the accountants appointed by the Board of Trade to inquire into the costs of production and financial results of the shale industry (as carried on by the undertakings associated with Scottish Oils, Ltd.) for the six months ending September 30, 1925, has recently appeared, and it makes very gloomy reading. The inquiry was held at a time when the industry was not only suffering severe economic depression, but also was harassed by acute labour troubles, the culmination of a long and critical period of commercial stress. As a result of the audit, the accountants find that there has been a net loss on the shale oil operations of the companies concerned of 77,822*l*. (for the six months in question), without allowing for plant and works depreciation; if the latter are included, the figure reaches 177,519*l*. The accounts for the same period, after allowing for income and expenditure apart from shale oil operations, and before making any provision for depreciation, show a loss of 57,776*l*. Thus the position of the industry is really quite as critical as has been evident from reports in the daily press, and it is not surprising, therefore, to find that the accountants propose that those works showing the heaviest loss per unit of output should be closed down If this policy is carried out, it will result in the cessation of operations in the Tarbrax Crude Oil Works and Mines, the Dalmeny Crude Oil Works and Ingliston Mine, the Broxburn Crude Oil Works with the Broxburn and Newliston Mines, and the Broxburn Refinery. This would mean that the remaining mines would presumably supply shale to be treated principally at the well-known Oakbank and Pumpherston refineries. There are many contributing factors to this decline of the Scottish shale industry, chief of which is undoubtedly the competition which has to be faced with regard to products from natural petroleum, and so long as the markets are swamped with such products at existing prices, so long will the oil shale industry remain at a disadvantage, both from the point of view of contemporary economics and of future development

THE Russian Society for the Study of the Urals, Siberia and the Far East is publishing, in conjunction with the All-Russian Central Executive Committee for Assistance to Northern Tribes, a new periodical, *North Asia*, devoted to the study of the northern Asiatic territories of Russia. The journal has the support of the Chief Department of Scientific Institutions (Glavnauka) and is edited by V. Vilensky-Sibernakov. The editorial staff includes a number of well-known authorities in various departments of science, economics and history. The main object of the new journal is the investigation of the economic problems of Siberia and the amelioration of the position of its native tribes. The four numbers of *North Asia* already issued contain a series of articles dealing with the natural resources of the country, its trade and industries, and a prominent place is given to sociological and ethnographical questions. There are also a number of papers on the geography, geology and history of various parts of the country. Apart from the original articles, the journal contains reviews of reports presented to the Society, bibliographical notices, and the texts of administrative and legislative Acts concerning northern Asia. All the articles are written in Russian and are not provided with summaries in a foreign language, only the title of the journal and the table of contents being translated into English.

SINCE the Belgian physicist Plateau, nearly a hundred years ago, devised a stroboscopic apparatus for the study of the vibrations of plates, many modifications of his type of apparatus have been used in practice They can be divided into two classes. In one class the moving object is only seen when it is passing through one phase of its motion. In the other, it is only illuminated when passing through one phase. In *La Nature* for December 19, a description is given of an apparatus of the latter class called the "stroborama," invented by L and A. Séguin. The great advantage of this apparatus is that it can be used in broad daylight, and so it should prove useful in studying the working of the various parts of the machines running in a factory. In a textile workshop, for example, the tension of the threads as well as the running of the reels can be examined. The electric power taken by the device is about 1 5 kilowatts. Neon tubes of great illuminating power are used. By means of a rectifier, a transformer and condensers, the tubes flash with great brilliance at periodic intervals adjusted to the period of the rotating or vibrating apparatus which is being examined. The accuracy with which the running of machines can be studied by the stroborama was demonstrated by the following experiment. Two scratches at a distance of 1 mm. apart were made on a disc. It was then rotated rapidly so that the scratches moved at a speed of 100 metres a second. When examined by the stroborama the scratches moving at this speed were plainly visible.

PROF. P. F. KENDALL, emeritus professor of geology in the University of Leeds, and Mr. T. Sheppard, of the Municipal Museums, Hull, have been elected honorary life members of the Yorkshire Conchological Society.

IT is announced in *Science* that Dr. Harris J. Ryan, professor of electrical engineering at Stanford University, California, has been awarded the Edison medal for the year 1925 by the Edison medal committee of the American Institute of Electrical Engineers "for his contributions to the science and the art of high-tension transmission of power."

THE Gold Medal of the Royal Astronomical Society has been awarded to Prof. Albert Einstein, for his relativity theory of gravitation. Prof. Einstein's name is widely known, even beyond scientific circles, through the theory of relativity originated by him in 1905 and generalised ten years later. Last year he was the recipient of the Copley Medal of the Royal Society.

THE New York correspondent of the *Times* states that Mr. Daniel Guggenheim is establishing a fund of 500,000*l.* to assist aeronautics until the freight and passenger carrying services of the United States are self-supporting. The fund is for the promotion of teaching and research in aeronautics and for the development of commercial aircraft, and the trustees are empowered to expend the whole in ten years.

THE Dominion Museum, Wellington, N.Z., has long been dangerously crowded. From the latest reports of the Director we learn that a large part of the Maori collections has been provisionally removed for exhibition to another building, and that the Government has decided to allocate the sum of 75,000*l.* towards the cost of a new building, provided that an equal sum is contributed by the public.

AT the meeting of the London Mathematical Society on Thursday, March 11, at 5 P.M., in the rooms of the Royal Astronomical Society in Burlington House, Mr. R. H. Fowler will give a lecture on "Atom-Mechanics." Members of other societies will be welcome as guests. It is hoped that Prof. A. Sommerfeld, of Munich, honorary member of the Society, will be present and speak after the lecture.

ACCORDING to a recent issue of *The Publishers' Circular*, a total of 13,202 new books and editions were issued in Great Britain during the year 1925. The number of new books was 9977. The corresponding totals for 1914 were 11,537 and 8863. Grouping the publications according to subject, the totals for the past year appear in the following order: (1) Fiction, (2) juvenile, (3) religion, (4) sociology, (5) poetry, (6) biography, (7) science, (8) technology. The order for 1914 was: (1) Fiction, (2) religion, (3) science, (4) sociology, (5) technology.

IT is stated in *Bull. No. 20 of the U.S.S.R. Society of Cultural Relations* that Prof. Elie Ivanov, well known for his numerous investigations on hybridisation by means of artificial insemination, is proceeding to French Guinea with the object of carrying out a series of experiments on the crossing of the human species with anthropoid apes at the station of the Pasteur Institute. Cross-breeding will first be attempted between the chimpanzee and orang-outang, and the baboon and gorilla. The human experiments will be conducted on representatives of some of the primitive African tribes.

THE Society for the Provision of Birth Control Clinics has issued its annual report for 1924–25. The major part of the Society's work is conducted through the Walworth Women's Welfare Centre, where 2069 new cases were dealt with during the year. From some of the cases quoted it can scarcely be doubted that such clinics under wise control serve a useful purpose. An important principle laid down by the Society is that every patient must be seen by a member of the medical staff, which is composed of medical women. We think that wherever practicable the staff should be married women. The Society depends entirely upon voluntary contributions, apart from a small nominal fee paid by patients.

A CONFERENCE was held by the Society for Experimental Biology at University College on January 7 and 8. At the morning session a general discussion was held upon respiratory pigments found in both plant and animal tissues, which was closed by Prof. J. Barcroft, who summed up the present position of the problem. In the afternoon papers were presented on the nature of protoplasmic surfaces on amœboid movement, on the hydrogen ion concentration and oxidation potential within cells, and on the occurrence of nuclear materials in certain plants devoid of differentiated nucleus. A large number of exhibits were shown during the tea interval The final session included papers on the physiological adaptation of abyssal Cephalopoda; on inheritance in *Limnæa stagnalis*; on structural growth in *Gammarus chevreuxi*, and on the relation of the effect of temperature on movement of the tail in tadpoles to its effect upon chemical reactions. At the end of the conference members of the society expressed their thanks to their hosts, particularly to Prof. D M S. Watson and Prof. J. P Hill.

COMMENTS by O. Hahn and L. Meitner on the experiments described by Dr. A. Gaschler on increasing the yield of uranium X from uranium by artificial means were referred to in NATURE of December 5, 1925, p. 827. Dr. Gaschler now writes to say that it is incorrect to state that he undertook experiments at the A.E.G. on the transmutation of uranium into uranium X with high-tension currents. He also states that accurate experiments could not be carried out at the Kaiser Wilhelm Institut fur Chemie in Berlin-Dahlem on account of lack of facilities. Most of Dr. Gaschler's work has been carried out in private laboratories.

WE have received from Messrs. Negretti and Zambra the "Easy-Setter" Thermometer Case. It consists of a clinical thermometer case of the usual type with a screw-on cap and provided with two short arms placed at right angles to the main part of the stem just below the cap. One arm is fixed to the stem, while the other is covered by a loose cylinder, so that by holding this arm between the thumb and forefinger the whole case can be made to rotate on this arm as axis. The fixed arm is milled to give purchase to the thumb and forefinger of the opposite hand in spinning the case. The principle is that of the centrifuge. The thermometer is placed in its case with the bulb downwards, the cap screwed on, and the instrument spun, when the mercury falls towards the bulb. The necessity of shaking the thermometer is thus obviated.

AN article appears in the *Fortnightly Review* for December, by J. B. C. Kershaw, on the domestic smoke problem. Data are available which show that the burning of coal in open grates contributes very largely to the haze of smoke which hangs over large towns. The use of gas coke and anthracite in closed stoves and of coal gas for heating has solved part of the domestic smoke problem, but the use of smokeless fuels in the open grate is essential before houses can be run without the production of any smoke whatever. We have also received a copy of the sixth report of the Smoke Abatement League of Great Britain, containing accounts of the annual meeting, smoke abatement exhibition, "smoke weeks," exhibits, lectures, literature, etc. The work of the League is fostered by local authorities, but the report indicates that it is hampered by lack of means.

AMONG the announcements by the Cambridge University Press of forthcoming books are "Clouds and Weather Phenomena," by C. J. P. Cave, the aim of which is the explanation of clouds, rainbows, mirages, the colours of the sky, and other atmospheric phenomena, and part 4 of "Ticks," which work is by Prof. G. H. F. Nuttall and others. The new part is by Dr. L. E. Robinson and deals with the genus Amblyomma.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A junior assistant in the physics department of the National Physical Laboratory, Teddington—The Director (February 1). Three technical assistants in the Torpedoes and Mining Department of the Admiralty—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (February 5). A junior scientific assistant in the Ignition and Electrical Department of the Royal Aircraft Establishment to assist in research in connexion with aircraft appliances—The Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (February 13, quoting A. 78). The Wilson Philological lectureship for 1926–27 in the University of Bombay—The Registrar, the University, Bombay (March 10). An assistant physicist to the Linen Industry Research Association, Lambeg, Co. Antrim—The Secretary.

Our Astronomical Column.

THE NEW COSMOGONY.—An interesting article by Dr. J. H. Jeans on "The New Outlook in Cosmogony" appears in the December number of *The Nineteenth Century*. "We now get the best picture of the universe," he says, "by thinking of it as consisting of a number of sub-universes, detached from one another like islands in an ocean." Our own star-system is one such universe—"a very big island indeed, with the sun not far from its centre."

Space is not infinite, so that there are a finite number of sub-universes. As a guess we may suppose that the most remote bodies of all in our universe are at four million light-years from us. The Andromeda nebula and the star cluster N.G.C. 6822, the most remote bodies the distances of which are yet known, appear to be about one million light-years away. The history of this universe is investigated in terms of the energy changes which we deduce must occur from the fact that the stars radiate more energy than they receive. All possible sources of their energy so far suggested have proved to be altogether inadequate except that arising from the annihilation of mass. According to the theory of relativity, loss of energy must entail loss of mass, and if we suppose the mass lost to be the actual "material" mass of the atoms—the so-called "rest-mass"—then there is a sufficient store to account for stellar radiation over the periods indicated by geological and other evidence.

The life of a star on this hypothesis can be calculated, and comes out to about 200 million million years. The sun has at present lived about seven million million years, so that the greater part of its life has yet to come, although as regards magnificence it has been and will be continuously on the wane. The great length of stellar life now contemplated makes it possible that many solar systems such as ours have been formed in the past by the close approach of two stars, although, even now, "a small proportion only of the stars in the sky are likely to be surrounded by families of planets and so to form possible abodes of life." Dr. Jeans sees no prospect of a utilitarian application of the conversion of mass into energy. "So far as can at present be seen, this dream is not destined to be fulfilled."

THE BRIGHTNESS OF SATURN'S RING.—B. Fessenkoff of the Astrophysical Institution, Moscow, describes in *Astr. Nachr.*, No. 5408, some interesting comparisons of the brightness of Saturn's ring as compared with the centre of the disc; the observations were made by him and Mr. Vsechsviatsky, using a Rosenberg-surface-photometer on the 7-inch refractor of the Koutchino Observatory.

A square 5″ in the side at the centre of the disc was compared with an equal square at each ansa of the ring. The result of comparisons on five nights in June last is that the centre is brighter than the western ansa by 0·414±0·0104 magnitudes, and than the eastern ansa by 0·317±0·0057 magnitudes. The difference of 0·1 mag. between west and east was clearly shown, but can scarcely be permanent. The above differences do not directly apply to albedo, since the centre of the disc is vertically illuminated by the sun, while the illumination of the ring is very oblique. Moreover, the measures were apparently made on the outer ring A, which is well known to be considerably less bright than the outer part of ring B. Thus the albedo of the latter probably exceeds that of the disc, a result that has been obtained from earlier measures.

Research Items.

IDENTIFICATION BY RECOGNITION.—In a pamphlet called "Mistaken Identity" (London: Longmans, Green and Co., 1925, 6*d*. net), Mr. Clifford Sully discusses the psychology of recognition. A recent famous case has demonstrated only too clearly that to identify a person as a particular person is neither an easy nor a trustworthy process. Because we so frequently in ordinary life see people in their usual setting, we fail to realise how little we actually observe at the moment, as against the amount we bring to bear from memories of previous occasions. Perception and accurate observation are not the simple processes they are rashly assumed to be, nor can honesty of purpose guarantee accuracy of observation. Reference to any text-book of psychology will give the reader evidence of the complicated and personal nature of ordinary perceptions, and this can be easily demonstrated by studying some of the well-known illusions. If errors are frequently made when the mind is critical and unperturbed, how much more likely are they to be made when emotion forms the background, which would naturally be the case in connexion with police trials. Complicate the problem still further with the effect of the newspapers on witnesses, and we have a state of affairs when the probability of unbiassed judgment is exceedingly low. No experimental psychologist would accept evidence given under such conditions, and yet it forms no insignificant part of police court evidence. Nor is a feeling of certainty any proof of the truth of the judgment. The author pleads that more attention should be paid to the psychology of human testimony.

THE "ARCHAIC CULTURE" OF MEXICO.—The sensational claims made for the antiquity of the relics of human occupation discovered beneath the lava flow in Mexico Valley give an added importance to the very careful investigations which were carried out there by Mr. A. L. Kroeber in the spring of 1924. A descriptive analysis of his results have now been published in Pt. 7 of vol. 17 of the *California University Publications in American Archæology and Ethnology*. The archaic culture first began to be recognised as such in 1911 or 1912. A particular phase of it is the so-called sub-Pedregalense—a culture found beneath the lava flow or pedregal of San Angel. This is a sheet of lava of about twenty sq. km or more in Mexico Valley which issued from the peak of Ixtle, covering earlier Pliocene or Miocene andesitic flows. In parts excavated on this occasion, the cultural deposits extended to a depth of so much as 3 metres below the lava flow. Careful comparison of material from this and other archaic sites, based chiefly on the pottery, have made it possible to work out a culture sequence which falls into four periods; but the absolute age cannot yet be fixed. In the geological sense the lava flow is quite recent. Culturally the archaic period is characterised by maize agriculture; but cotton may not have been in use, as spinning appears to have been undeveloped. All the important traits of the culture are found in more developed form in the Teotihuacan culture. While it includes the general objective features of Mexican religion, it precedes the individualisation of specific deities, symbols and acts of this religion. It has no specific features characteristic of any other area, such as the Pueblo, from which indeed it is definitely marked off by the occurrence of pyramid and step structures as well as other features.

MARQUESAN MUSIC.—Mr. E. S. Craighill Handy and Miss Jane Lathrop Winne have published in *Bull.* 17, *Bernice P. Bishop Museum of Honolulu* a study of the native music of the Marquesas Islands based upon material acquired by the former when a member of the Bayard Dominick Expedition of 1920–21. In the olden days, chanting accompanied practically every activity of life among the Marquesans and formed the central feature in most rites and festivities. Twenty-five different types of chants for use on different occasions were collected on Hivaoa alone. Although solo singing was in use it was choral singing that was distinctive of their music. When a song was required for a particular occasion, the head of a family hired an adept who composed words and music. A chorus was then assembled and instructed, a special house being built for the accommodation of the singers while instruction was proceeding if the song was a tapu chant. The type of chant determined the nature of the chorus, *i.e.* whether of young girls, mixed voices, men or old men. Three types of voices in each sex were recognised, and each song had an established voice or register. For instrumental accompaniment, drums of wood and shark skin, bamboo mouth flutes and small resonant sticks were employed. The songs themselves were recreational, eulogistic or religious, while the natives themselves divided them into tapu (those with a serious purpose in view) and non-tapu (old songs which had served their purpose and were chanted for amusement, or those which were purely recreational).

IRRIGATION IN INDIA.—The Public Works Branch of the Department of Industries and Labour of the Government of India has published the Triennial Review of Irrigation in India for the period 1921–1924, from which it is to be gathered that the average area irrigated annually in British India by Government works of all classes during the triennium was 27¼ million acres, as compared with 26¾ million acres, the average of the previous triennium. In general, the results obtained have been as good as, or better than, those of the previous period, the notable exception being the United Provinces. The decrease in the area irrigated in this territory (rather more than a million acres) is attributable mainly to the favourable seasons experienced during the triennium. The total capital outlay, direct and indirect, on irrigation and navigation works, including works under construction, amounted at the end of the year 1923–24 to Rs. 89,25 lakhs. The gross revenue for the year was Rs. 10,65 lakhs, and the working expenses, Rs. 3,77 lakhs; the net return on capital was, therefore, 7·71 per cent. It is pointed out that the capital invested includes considerable expenditure upon three projects of the first magnitude, namely, the Sarda-Oudh canals, the Sutlej Valley and the Lloyd (Sukkur) Barrage projects, which are under construction and contribute nothing at present by way of revenue. The last named is the greatest irrigation scheme ever undertaken, and, when completed, it is expected to inaugurate an era of unprecedented prosperity for the Province of Sind in which it is situated. The Secretary of State for India sanctioned the project in April 1923, and the total expenditure on works, mainly of a preliminary character, including special tools and plant, during the year 1923–24 was nearly Rs. 23¼ lakhs. The Sutlej Valley project in the Punjab, sanctioned in the year 1921–22, has made good progress, and the Sarda-Oudh canals are well advanced.

SALMON AND RIVER POLLUTION.—An interesting and important report on pollution of the River Tyne Estuary, 1922–1924, by Miss Edith M. Meek, produced by the Tyne Pollution Sub-Committee, is published in the Dove Marine Laboratory Report for the year ending June 30, 1925. Pollution from various sources has resulted in a serious deterioration of the salmon industry in tidal and non-tidal waters; the ascending and descending fish both being involved, although it is specially the smolts which suffer. The smolts, about seven inches long and usually just under two years old, migrate down the river in large shoals at certain periods, and, unlike the older ascending fish, are not able to take advantage of specially favourable conditions occurring irregularly; they thus frequently enter polluted areas and are destroyed in numbers. The chief causes of pollution are sewage and effluents from works, the former causing suffocation through lack of oxygen, the latter direct poisoning Of these, however, the sewage problem is by far the more dangerous, and crude sewage is the dominant factor in the pollution of the Tyne Estuary. The report of the sub-committee is of the opinion that sewage is by far the worst enemy of the industry. Two natural counteractions are the water temperature and the presence of freshets of pure upland water resulting from rainfall, which descend in time of flood, thus forcing the polluted water out to sea and enabling the ascending fish to take advantage of the pure water. Low temperature and abundant rainfall are essential for the escape of the fish. Appendices on the bacteriology and plankton contents of the polluted areas, with statements of the numbers of fish caught, follow the report, with accounts of physiological experiments undertaken by Miss Meek, mainly on the amount of dissolved oxygen and the keeping of fish in observation tanks in the polluted water.

AN ARCTIC FISH IN BOSNIA.—In the *Novitates Musei Sarajevoensis*, No. 3 (November 1925), Dr. St. J. Bolkay records the discovery of the capelin (*Mallotus villosus*) fossilised in nodules in a clay at an altitude of 580 metres in S.E. Bosnia. The nodules resemble those containing the same fish which are often found in glacial clays in Greenland and near Ottawa in Canada. The fish exists at present in great numbers in Arctic seas and in the colder parts of the North Atlantic and Pacific Oceans. Its occurrence in clays of the Pleistocene period so far south as Bosnia is therefore a fact of great interest.

THE CLASSIFICATION OF THE FORAMINIFERA.—The attention of students of recent and fossil Foraminifera may be directed to Joseph A. Cushman's introduction to the morphology and classification of the Foraminifera (*Smithsonian Misc. Coll.*, vol. 77, No. 4, 1925). A brief account of the life-history, of the structure of the test, and of the distribution in present oceans is followed by suggestions for collecting, washing, sorting, and mounting recent and fossil examples. The terms employed in systematic descriptions are briefly commented upon and a classification into ten families follows. Under each family the constituent genera are concisely defined, and in most cases a figure is given From the point of view of the student of the test the systematic summary is admirable, but if the author had added an account of the cytoplasm and nucleus in two or three typical cases, and fuller details of the life-history, the memoir would have had a still wider appeal.

THE LIFE-HISTORY OF GORDIUS.—Dr. Jan Švábeník has issued (*Publ. Fac. Sci. Univ. Masaryk*, 58, 1925) the results of his observations on the life-history of *Gordius tolosanus*, one of the "hair worms." The primary host of this worm is the larva of some midge (Chironomidæ); Corethra and Anopheles are not infected. The first host becomes infected not by way of the mouth, but by the entry of the larvæ of the worm through the soft skin of the appendages at the hind end. The author has succeeded in infecting various carabid beetles by feeding them with midges developed from infected larvæ. The largest number of worms found in one beetle was twenty. Attempts to infect Pterostichus, Haptoterus, and Poecilus had little success, and Forficula failed to become infected. It would appear that each species of Gordius has its specific primary and secondary hosts. The development of the Gordius larva in these hosts is described and figured. The adult Gordius leaves the fat body of the beetle and issues to the exterior in the spring, the parasitic life in the two hosts having extended from July of one year to February of the next. The Gordius is free living for about four months. The author states that the gonads are endodermic in origin, and he regards the Nematomorpha as a very old group.

ALTERNATE BEARING YEARS IN TREES.—This phenomenon is very familiar in horticultural literature, so many fruit trees having a well-established habit of bearing well in alternate years; much horticultural pruning practice is directed towards restricting a habit which cannot unfortunately be given an inverse correlation with market price for the fruit. Now the same habit is reported by Mr. F. Kingdon Ward for the tree rhododendrons in his interesting account of his eighth collecting expedition in Asia, which is appearing in the *Gardener's Chronicle*. This subject is discussed by him in the issue of December 19, which contains an interesting account of a very difficult but interesting journey to the falls of the Tsangpo.

CYTOPLASM AND CHROMATIN.—Prof. Charles J. Chamberlain regards these two familiar concepts of cell-structure from the point of view of the morphologist, and in the light of his wide experience of the structure of the very large cells forming the egg cells of the Cycads, in the *Botanical Gazette* for October 1925. Prof. Chamberlain points out that these eggs are the largest in the plant kindgom, reaching a length of 6 mm., with a diameter of 2 mm., and the nuclei are exceptionally large; thus the egg nucleus of *Dioon edule* may reach a diameter of 500 μ. Prof. Chamberlain endeavours to show that in the cycad egg cytoplasm there is an unbroken series, from large vacuoles of 100 μ or more in diameter, down to the smallest spaces demanded by the theory of Bütschli and Wilson, and that the largest and smallest spaces are of the same morphological nature. He also affirms his belief that chromatin in plants is a vacuolated substance like the cytoplasm, and that, in the plants studied, there are no such structures as chromomeres upon a linin ribbon; and he predicts that theories which cannot be reconciled with a vacuolated structure of the chromosome will have to be abandoned. It is interesting to have this definite expression of morphological opinion, though the question at issue will require examination from a much wider basis than is provided by morphology.

THE ENSTATITE-AUGITE SERIES OF PYROXENES.—The importance of the pyroxenes of the enstatite-augite series, generally referred to as *augite*, has not yet been recognised in text-books, though the last decade has seen the publication of many papers on plateau-basalts in which the very widespread occurrence of that series has been conclusively established. Dr. L. L. Fermor has conveniently summarised the evidence in the *Records of the Geological Survey of India*, vol. 58, Pt. 3, 1925. He confirms Washington's conclusion that the common pyroxene of the Deccan Traps belongs to the enstatite-augite series of Wahl, the characteristic feature of these mixed pyroxenes being a small optic axial angle. It is pointed out that a research into the system $CaSiO_3$—$FeSiO_3$ is necessary before the homogeneous ferruginous varieties can be adequately explained. From the natural occurrence of monoclinic pyroxenes a provisional attempt at a classification and determinative scheme has already been made by Dr. Bror Asklund (*Sveriges Geologiska Undersökning*, Årsbok 17, Ser. C, No. 325, Stockholm, 1925). In this important paper it is shown that by taking into consideration both optic axial angles and refractive indices, the chemical composition may be approximately deduced from optical tests. Both writers direct attention to the fact that richness in $FeSiO_3$ favours the growth of a single homogeneous pyroxene, whereas both monoclinic and orthorhombic types tend to separate from magmas richer in magnesia. Further complications due to the presence of alumina have not yet been satisfactorily analysed.

EFFECTS OF PRIMARY SPHERICAL ABERRATION.—An experimental study of the effects of varying amounts of primary spherical aberration on the location and quality of optical images has been made by Miss H. G. Conrady, and her results are published in the *Journal of the Royal Photographic Society* (January, p. 9). She has worked out results by the geometric theory, by the physical theory, and by experimental work, and found that the results of these three methods do not agree, except of course in the paraxial region. "Beyond the Rayleigh limit, neither the physical nor the geometrical curves appear to agree with what actually occurs." The author finds that "without doubt" the presence of primary spherical aberration does increase the depth of definition of a lens system. As to resolving power, the curve based on the geometrical theory "obviously has no recognisable bearing on the actual facts." The experimental results agree closely with the physical theory up to about the Rayleigh limit, but beyond it there is a practical loss of resolving power. Miss Conrady gives full details of her work, and generalises her results so that they are applicable to any lens system.

THE γ-RADIATION OF THE ACTINIUM SERIES.—In the issue of the *Zeitschift fur Physik* of Nov. 28, Fraulein L Meitner, using measurements of the β-ray spectra of radioactinium and its disintegration products made by her in collaboration with Dr. O. Hahn, discusses the nature of the γ-radiation which is assumed to produce them. Both radioactinium and actinium X radiate α-particles, and possess a somewhat complicated γ-ray spectrum. Owing to their short life it is possible to employ them in very thin sheets, with the result that the lines of the β-ray spectrum are much sharper than in the case of the longer lived α-radiator radium. It is shown that the photo-effect by which the β-rays are liberated actually takes place, in both cases, not in the disintegrating atom, but in that which results from the disintegration; it follows that the γ-radiation is emitted after the α-particle has been thrown out, and represents the spectrum of the nucleus after disintegration. It is shown that the absorption within the atom, or more correctly the Rosseland photo-effect produced without actual γ-radiation, takes place, when there are several electronic levels, only in the one for which the energy of expulsion is a maximum, in the case of the L levels, for example, only in the L_1-level. The probability of absorption of the K-radiation within atoms with atomic numbers $Z=88$ and $Z=86$ is found to be of the order of ten per cent.

THE DURATION OF X-RAY PULSES.—Previous measurements of the time during which an individual X-ray pulse continues to emit energy (*Abklingungszeit*) have led to contradictory results. Dr. F. Kirchner, in the *Annalen der Physik* for November, describes an improved method for the direct measurement of the velocity of cathode rays based on that of Wiechert, and shows how it can be adapted so as to measure the *Abklingungszeit*, t_1, of X-rays. Cathode rays are emitted in large numbers from an incandescent oxide-coated cathode, are accelerated by a powerful field, passed through holes in two screens so as to form a narrow beam, and then through a rapidly alternating electric field produced by means of two hot-wire cathode valves. The beam is thus deflected in opposite directions in turn, and falling on a screen with a hole, which lets it through when it is at one of its extreme positions, falls on an anticathode producing a sudden rush of X-rays. These pass into another tube and fall on a metal cathode, from which they liberate a swarm of photo-electrons, which are accelerated by a suitable field, formed into a narrow beam by means of diaphragms, and passed through an alternating field, worked by the same valve circuit as the first, which deflects the beam to and fro. In one position the electrons can pass through a hole in a screen into the collector of an electrometer, but this will only happen when the phase relations between the field and the electron swarms are right. This depends on the length of path and the velocity of the electrons, the phenomena being also influenced by the time t_1 and by the time t_2, which is needed for the liberation of a photo-electron. The measurements show that $t_1 + t_2$ is smaller than 7×10^{-18} sec. when the K-radiation of iron is employed; t_2 is shown to be of the same order, so that the duration of an X-ray pulse must be small

THE CATHODE RAY OSCILLOGRAPH.—In the *Journal of the Franklin Institute* for December, F. R. Terroux suggests some useful improvements of the cathode-ray oscillograph which will greatly extend its usefulness. At the present time there are two distinct types of this instrument, a modified form of Braun tube and a type originally suggested by Sir Joseph Thomson and developed by D. A. Keys and A. B. Wood. Although these types have proved of value in research, there are difficulties in operating them. In the Braun type the cathode beam traces its deflexion on a fluorescent screen inside the glass tube and the luminous streak is photographed by an ordinary camera. In order to get a good image the curve must be retraced several times by the cathode beam, and this greatly limits its usefulness. In the Thomson type, the photographic plate is enclosed within the evacuated apparatus. Thus a single transit of the cathode beam will leave a distinct trace on the plate. Whenever the plate is to be inserted or withdrawn, however, the apparatus must be unsealed or evacuated anew. Mr. Terroux obviates this disadvantage as follows. A plane sheet of quartz is sealed across the end of the oscillograph tube, opposite to the cathode. A fluorescent screen is deposited on the inner side of the quartz, and a photographic plate is placed flat against the outer surface. Thus when the cathode beam traces a luminous curve on the screen, the curve would be reproduced directly on the photographic plate and the losses due to dispersion and absorption would be eliminated. There are three obvious advantages of this instrument as compared with the usual type. First, a vacuum pump is unnecessary as the tube is permanently sealed; secondly, no system of lenses is needed as the plate is placed against the quartz; and thirdly, the instrument can be used to study transient phenomena.

Prize Awards for 1925 of the Paris Academy of Sciences.

AT the annual public meeting of the Paris Academy of Sciences, held on December 14, the awards for the year 1925 were announced as follows:

Mathematics.—The Francœur Prize to Georges Valiron.

Mechanics.—The Montyon Prize (Mechanics) to René Risser for his "Essai sur la théorie des ondes par émersion." The Poncelet Prize to Denis Eydoux for the whole of his work in hydraulics.

Astronomy.—The Lalande Prize to Georges Fournier for his observations on planet surfaces and atmospheres. The Valz Prize to V Michkovitch for his works on stellar statistics. The Pierre Guzman Prize between Eugène Antoniadi (2500 francs) for his researches on the surface of the planets, Fernand Baldet (2500 francs) for his researches on the constitution of comets, and Benjamin Jekhowsky (2500 francs) for his work relating to the determination of the elements of the minor planets. The G. de Pontécoulant Prize to Paul Caubet for his work on the proper motion of the stars, the inequalities of the movement of the moon, and perturbations of the planet Ino.

Geography.—The Gay Prize to Léon Lutaud for his memoir on the tectonic and morphological study of Provence. The Tchihatchef Prize to V. A. Obroutcheff for his explorations in eastern Siberia and northern China

Navigation.—The Prix de la Marine between Pierre Marti (4000 francs) for his work on the application of sound waves to the determination of depths and positions, and André Nègre and André Vinsot (2000 francs) for their studies on the navigation of torpedoes.

Physics.—The Kastner-Boursault Prize to Eugène Darmois for his work on rotatory polarisation (natural and magnetic) and on the complex compounds of molybdic and boric acids. The Gaston Planté Prize to Joseph Bethenod for his work on the production and utilisation of high frequency alternating currents. The Hébert Prize to Édouard Roth for his work entitled "Alternateurs et moteurs synchrones." The Henri de Parville Prize to Gustave Ribaud for his work on absorption spectra and electric induction furnaces. The Hughes Prize to Jean Cabannes for his work on the molecular diffusion of light The Clément Félix Foundation (grant of 2500 francs) to Georges Déjardin for the continuation of his researches on the excitation potentials of gaseous spectra.

Chemistry.—The Montyon Prize (Unhealthy Trades) to Maurice Javillier for his work in biological chemistry. The Jecker Prize (in equal parts) between René Locquin for his work in organic chemistry and Charles Dufraisse for his researches in organic chemistry, stereochemistry, and on autoxidation. Cahours Foundation to Léonce Bert for his work in organic chemistry. The Berthelot Prize to Émile André for his work in thermochemistry, the analysis of fats, and on squalene. The Houzeau Prize to François Bourion for his work on the preparation of anhydrous chlorides and in industrial chemistry.

Mineralogy and Geology.—The Cuvier Prize to Léopold Kober for his work entitled "Bau und Entstehung der Alpen" and for the whole of his stratigraphical and tectonic work on the Eastern Alps. The Delesse Prize to François Grandjean for his researches on anisotropic liquids and on the geology of Corsica. The Raulin Prize to Georges Dubois for his researches on the Quaternary of northern France. The Joseph Labbé Prize to Marcel Solignac for his work on the geology of Tunis.

Botany.—The Montagne Prize between André de Puymaly (1000 francs) for his researches on algæ and Auguste Loubière (500 francs) for his work entitled "Recherches sur quelques mucédinées caséicoles." The Jean Thore Prize to Marcel Denis for his studies on the distribution of plants. The de Coincy Prize to Henri Chermezon for his work on the Cyperaceæ.

Anatomy and Zoology.—The Cuvier Prize to Louis Mercier for the whole of his work in zoology. The Savigny Prize to Eugène Séguy for his book on the mosquitoes of Egypt and Syria.

Medicine and Surgery.—Montyon Prizes (2500 francs) to Edmond Sergent, André Donatien, Louis Parrot, Félix Lestoquard, Edmond Plantureux, Mlle. Henriette Rougebief, of the Algerian Pasteur Institute, for their work entitled "Les piroplasmoses bovines d'Algérie", to Eugène Wollman for his memoirs on proteolysis and the Abderhalden defence ferments; and to Léon Bérard and Charles Dunet for their work entitled "Cancer thyroïdien." Honourable mentions (1500 francs) to Émile Kohn-Abrest for his work on toxicological chemistry; Georges Rosenthal for his researches on blood transfusion; and Camille Lian and André Finot for their work entitled "L'hypertension artérielle." Citations to Henri Colombiès for his experimental and clinical researches on cholesterol and its metabolism; Charles Dejean for his memoir entitled "Le canal de Cloquet, ou canal central du corps vitré"; Edmund Libert for his "Précis de pathologie générale"; Philippe Bellocq for his work entitled "L'os temporal chez l'homme adulte. Iconographie et description de l'os et de ses cavitiés." The Barbier Prize between Mlle. Fernande Coupin for work on the nervous system of vertebrates and Raymond Weissenbach for a work entitled "Les syndriomes anémiques." The Bréant Prize (arrears) to Gaston Ramon for his work on the titration of diphtheric toxin and antitoxin by means of flocculation and on anatoxines The Godard Prize to Robert Courrier for his memoir on the sexual cycle in the female of mammals. The Mège Prize to Roger Douris for his book on the analysis of the blood. The Bellion Prize to Alfred Thooris for his book "La vie par le stade." The Larrey Prize to Jules Beyne for his work on the protection of the aviator against the effects of atmospheric depression by means of oxygen apparatus.

Physiology.—The Montyon Prize to Mlle. France Gueylard for her book "De l'adaptation aux changements de salinité. Recherches biologiques et physicochimiques sur l'épinoche" The Pourat Prize to Serge Métalnikov for his work on the intracellular digestion and immortality of the Protozoa The Philipeaux Prize to Pierre Mathieu and Henri Hermann for their researches on the respiratory function by use of the tracheal air divider.

Statistics.—A Montyon Prize (1000 francs) to Maurice Fréchet for the whole of his work on the calculus of probabilities. Honourable mention (500 francs) to Maurice Halbwachs for his book entitled "Le Calcul des probabilités à la portée de tous."

History and Philosophy of Science—The Binoux Prize to Albert Maire for his bibliography of Pascal. The Henri de Parville Prize to Émile Hegh for his recent work on Termites. The Jules and Louis Jeanbernat and Barthélemy de Ferrari Doria Prize to Georges Bouligand for his work on harmonic functions.

MEDALS.—Berthelot Medals to Maurice Javillier, Charles Dufraisse, Léonce Bert, Émile André, and François Bourion.

GENERAL PRIZES.—The Grand Prize for physical sciences to Georges Mouret for the whole of his work in geology. The Lallemand Prize to Mlle. Piera Locatelli for her researches on the influence of the nervous system on regeneration. The Petit d'Ormoy Prize (Mathematical Sciences) to Jules Drach for the whole of his work. The Petit d'Ormoy Prize (Natural Sciences) to Maurice Caullery for the whole of his work in zoology and biology. The Saintour Prize to Arnaud Denjoy for his works on the calculus of primitive functions. The Lonchampt Prize between Albert Frouin and Mlle. Maylis Guillaumie (2000 francs) for their memoir entitled "La nutrition carbonée du bacille tuberculeux," and Paul Cristol (1000 francs) for his work on cancerous tissues. The Wilde Prize (in equal parts) between Raymond Jouaust for his researches on photometry and radiotelegraphy and René Mesny for his researches on radiogoniometry and short Hertzian waves. The Gustave Roux Prize to Edmond Sollaud for his researches on the embryogeny of the crustaceans The Thorlet Prize to Adolphe Richard.

SPECIAL FOUNDATIONS.—The Lannelongue Foundation between Mmes. Cusco and Rück. The Laplace Prize to D. J. L. Bichelonne. The L. E. Rivot Prize between D. J. L Bichelonne (750 francs), M. E P Pascal (750 francs), P. C. Adam (500 francs), and R. A. M. Lehuédé (500 francs).

GRANTS FOR SCIENTIFIC RESEARCH.—The following grants for research were announced:

The Tremont Foundation to Alexandre Meunier for his cartographical work on French Western Africa. The Gegner Foundation to Léon Bultingaire for his work in connexion with the preparation and publication of the catalogue of scientific publications in the libraries of Paris. The Hirn Foundation to Georges Corroy (2500 francs) for the cost of publication of a work on stratigraphy. The Becquerel Foundation to André Danjon for his astronomical works.

The Loutreuil Foundation.—I. Grants to establishments named by the founder:

(1) The National Museum of Natural History. Louis Mangin (8000 francs) for the maritime laboratory of the Museum. Désiré Bois (4000 francs) for the publication of the third volume of a guide to the collections of plants cultivated at the Museum.

(2) The National Veterinary School of Alfort. 12,000 francs to the library of this establishment for the purchase of books and more especially of periodicals.

(3) The National Veterinary School of Lyons. Joseph Basset (3000 francs) to pursue his researches on a new method of vaccination for anthrax and on the infectious diseases of the dog. Gabriel Marotel (1000 francs) for the continuation of his researches on the treatment of the parasitic diseases of animals. L. Jung (1500 francs) for pursuing his researches on the rôle of fats in the utilisation of food albumen and on the mechanism of rumination and vomiting. Armand Tapernoux (1000 francs) to continue his researches on the hydrogen ion concentration of biological liquids, particularly of milk. M. Tagand (1000 francs) to enable him to undertake, under the direction of M. Lesbre, researches on teratogenesis in various domestic mammals.

(4) The National Veterinary School of Toulouse. Jules Girard and Pierre Pons (2000 francs) for the continuation and development of their researches on the factors modifying growth (temperature, special diet, castration) P. Bru (1000 francs) for researches on pulmonary emphysema in comparative pathology. Charles Hervieux (1000 francs) for researches on the putrefaction of food.

II. Grants to establishments admitted for one year by the President. Conservatoire National des Arts et Métiers Jules Lemoine (2000 francs) for the purchase of apparatus for the physical laboratory. Gabriel Kœnigs (1500 francs) for the translation of American patents concerning various mechanical arrangements.

III. Independent grants. Jules Barthoux (4500 francs) for mineralogical researches in Algeria. General Sebert (5000 francs) for the publication of documents relating to the creation of the Office central de documentation technique et industrielle. Jacques Chevalier (1000 francs) for the purchase of apparatus for researches on experimental psychology at the new laboratory at the University of Grenoble. The Comité français de géodésie et géophysique (Section 6. Atmospheric electricity), 14,000 francs. Mme. Yves Delage (4000 francs) for the publication of a volume of "L'Année biologique." René Dubrisay (3000 francs) for the purchase of apparatus to pursue his researches in capillary chemistry. Louis Dunoyer (13,000 francs) to pursue his researches on certain problems relating to modern methods for the measurement of high vacua The Fédération française des Sociétés de Sciences naturelles (7000 francs) as a new contribution to the publication of the "Faune de France" Edmond Friedel (2500 francs) for his researches on the diffraction of the X-rays by smectic bodies. Pierre Lesne (2000 francs) for the pursuit of his researches on the coleopterological fauna of peat. Charles Marie (5000 francs) for assisting the publication of the annual tables of constants of chemistry, physics, and technology. Charles Moureu (4000 francs) for the purchase of a new type of bomb calorimeter. The Marseilles Observatory (3000 francs) for the publication of the *Journal des Observateurs* Ém. Passemard (3000 francs) for geological exploration in Syria Jean Tilho (4000 francs) for the publication of maps resulting from his explorations of Tibesti, Borkou, Erdi, and Ennedi J. Tissot (5000 francs) for assisting the publication of a work concerning the constitution of animal and plant organisms Mlle. Y. Trouard-Riolle for researches in genetics Père Lejay to complete his researches on atmospheric electricity

(The total grants from the Loutreuil Foundation given this year amount to 124,500 francs.)

The Bouchard Foundation to Henry Cardot for his work on adaptation to change of environment, heredity, Protozoa, and micro-organisms.

Annual Meeting of the Geographical Association.

"THE world about us is the greatest of all laboratories, and Nature is the greatest demonstrator." Even by the wayside, to and from school, as Prof. J. L. Myres showed, we may see processes in operation shaping the geography of the homeland and illustrating the geography of other lands. The rhythmic flow of a river, as elaborated by Dr. Vaughan Cornish, offers ample scope for training in scientific observation. Only by seeing can the eye be trained to appreciate the complex of Nature and man, the adjustment of life—social, economic and political—to its physical environment.

Sir Halford Mackinder stressed that description must be the central fact in the teaching of geography. Material must be obtained before there can be any study of causation. To describe truly, artistically and with a true sense of proportion is to reach the highest art, and such description is essential to the appreciation of a regional organisation and entity. On these grounds, Sir Halford placed geography among the arts rather than among the sciences, though, as Prof. Lyde pointed out, artistic description implies scientific method.

Regional description demands, one might almost say presupposes, a cadre or framework. Prof. P. M. Roxby dealt with the concept of natural regions in the teaching of geography, drawing his illustrations from China. The land frontiers, regarded as a zone rather than a political line, separate major regions differing from each other physically and biologically no less than culturally and economically. This difference between China and her neighbours being greater than the difference between the sub-regions of China, makes for unity in spite of its regional diversity. The major sub-regions also—the North China plain, the lower Yang-tze basin, Szechwan, south-east China and the highlands of Yunnan—reveal the same coincidence, broadly speaking, of natural and cultural divisions. Here, then, is a cadre, apparently permanent, giving definition to the geographical region with its internal complex and its external relationships.

Mr. A. G. Ogilvie outlined the extent to which such studies have been carried in South America and Africa and defined broadly the line upon which future geographical research must proceed. In both continents rapid progress is being made in topographic surveys and in the production of maps adequate for the needs of research workers. But much remains to be done. Under the auspices of the American Geographical Society much geographical work has been done in South America and more is being undertaken In Africa little geographical research has as yet been carried out, especially in British territory

Sir John Russell, in his account of "Cotton and the Nile," gave geographers two illustrations of great interest in the complexity and change of regional activities. Naturally the Anglo-Egyptian Sudan offers an important field for extensive cotton cultivation. Can the Nilotic tribes be induced to change their mode of life and grow cotton for the European market? In Egypt, on the other hand, a very distressing situation has arisen. After the expenditure of millions of pounds sterling on great schemes of irrigation, the land has begun to deteriorate quickly. For the first time in the long history of Egypt, it has been necessary to import fertilisers. Egypt is now a large buyer of nitrate of soda for the growing of crops.

Geographical economics, a term applied to the study of economics on a regional or geographic basis, forms one of the most important and most urgent fields for research. What are the fundamental causes, for example, why Malaya and British Guiana, comparable in size, position, climate and fertility of soil, should differ so widely in their total population and the export of domestic products? One has a population of 3,300,000 with export value of 78,714,225*l*. (1923), the other a population of 300,000 and export value of 3,757,647*l*. This illustration, quoted by Mr. Ormsby Gore, served as an introduction to his presidential address on "The Economic Geography of the British Empire." Under present conditions, some regions are primary producing countries, others are manufacturing. The two are complementary and both require that their economic life should be studied on a regional or geographic basis, however fully trade statistics may be studied in the abstract. To many statesmen in 1763, Guadaloupe with its slaves and sugar appeared of far greater worth than the vast forest and prairie lands of Canada because the potential geographic value was not suspected. The observations of a trained geographer capable of getting the economic survey away from a narrow view of economics on to a much wider plane are of immense value, not merely to those engaged in administration, but also for those engaged in commerce. Unfortunately, little has as yet been done in the British Empire in this direction Innumerable factors enter into an acceleration of primary production with the consequent increase of purchasing power of manufactured goods. Even in manufacturing countries, Sir Richard Gregory pointed out, inventive genius and adaptability may serve or create new needs and thus maintain or even enlarge the volume of trade between manufacturing and primary producing countries.

Altogether the papers presented at the annual meeting of the Geographical Association on January 7-9 furnished an excellent series illustrative of the theory and practice of geography.

Geodetic Observations in the United States of America.

AN official coastal survey of the United States was first authorised under President Jefferson in 1807, and since that date, with some vicissitudes, continual progress has been made in the survey of the country, both coast and inland. The Coast Survey, on account of its extended work, was renamed the Coast and Geodetic Survey, as now, in 1878. Besides the work done by this department, determinations of latitude, longitude, and azimuth have been made at various times by the U.S. Lake and Geological Surveys, the U.S. General Land Office, the U.S. and Canada Boundary Commission, the U.S. Army, and other bodies. Some of these determinations have hitherto remained unprinted, while others are scattered throughout many reports. The Coast and Geodetic Survey has therefore collected them all in one volume and made them readily and permanently available for scientific purposes.[1]

The preparation of the volume has been made by Sarah Beall, mathematician to the Survey, who acknowledges the help given by Dr. Bowie, chief of the Division of Geodesy, and all the other members of the staff of this Division. The compilation has been done in an admirably workmanlike fashion, with concise but adequate historical introductions and descriptions of the various classes of observations. There are four chapters dealing respectively with longitudes, latitudes, azimuths, and deflexions of the vertical, followed by a final chapter (occupying rather more than half the volume), giving detailed particulars of the stations. In each case the principal instruments and methods of observation and computation are described and illustrated, and the other relevant facts are summarised.

For a volume of this kind the letterpress contrives to be surprisingly interesting. The bulk of the volume, apart from the final chapter, is naturally devoted to tabular matter; the results (both as observed, and after making the various necessary adjustments) are given in order of date, the probable errors being indicated, except in the case of the deflexions of the vertical Reference to any individual station is facilitated by a comprehensive index to stations. All those who have occasion to make use of geodetic data for the United States will feel grateful to the author, and to Dr. Lester Jones, the Director of the Survey, for this very valuable collected work.

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[1] Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 283. "Astronomic Determinations by United States Coast and Geodetic Survey and other Organizations." By Sarah Beall. Special Publication No 110, pp. v+357+13 plates. (Washington. Government Printing Office, 1925.) 80 cents.

Contemporary Birthdays.

January 23, 1856. Brig.-Gen. Sir Henry C. L. Holden, K.C.B., F.R.S.

January 27, 1864. Prof. John Walter Gregory, F.R.S.

January 27, 1856. Prof. Edward B. Poulton, F.R.S.

Sir HENRY HOLDEN was born at Cheltenham. Educated at Ipswich School, he joined the Royal Military Academy, Woolwich, afterwards entering (1875) the Royal Artillery, and then came service in India, until 1881. The inventor of many instruments connected with electrical science and artillery problems, he became Superintendent of the Royal Gun and Carriage Factory at Woolwich; afterwards he was (1914–16) Director of Mechanical Transport at the War Office.

Prof. J. W. GREGORY, geologist and exploring traveller in many regions, was educated at Stepney Grammar School. Originally he was associated with his father in the wool trade, but in 1887, having qualified for an assistantship in the Geological Department of the British Museum, he henceforth devoted himself to scientific pursuits. He left London and Government service in 1900 to take up the post of professor of geology and mining at the University of Melbourne (combined with survey work), returning in 1904 on his election as professor of geology at the University of Glasgow. A voluminous writer in different branches of geology, Prof. Gregory has studied in particular the features of the Alps, the Mediterranean basin, Africa, the West Indies, and Australia. Among his publications are "The Origin of the Great Rift Valley in East Africa," "The Origin of Fjords," "The Evolution of the River Systems in Chinese Tibet." Prof. Gregory was president of the Section of Geology, British Association, 1907, and of the Section of Geography, 1919.

Prof. E. B. POULTON was born at Reading, the son of an architect resident there. He was educated in the first instance at a private school, afterwards entering and graduating at Jesus College, Oxford. For many years (and still) Hope professor of zoology in the University of Oxford, early a Burdett-Coutts university scholar, an ex-president of the Oxford Society, lecturer in natural science at Jesus College, sometime tutor at Keble, formerly a member of the Oxford Hebdomadal Council—in short, all Prof. Poulton's traditions and implications savour of Oxford. President of the Linnean Society, 1912–16, he was awarded (1922) the Linnean gold medal, in token of the Society's appreciation of services to zoological science. Sir A. Smith Woodward remarked at the time that Prof. Poulton had begun by traversing a wide field, from bone-caves and Pleistocene geology to the structure of the tongues of marsupials—histological work which culminated in the interesting discovery of true teeth in the embryo Ornithorhynchus. Prof. Poulton's inclinations, however, were always towards entomology, and for many years he has been regarded as the chief exponent of the theory of protective resemblance and mimicry in insects. His keepership of the Hope collection at Oxford has resulted in the creation of a museum of entomological specimens illustrative of variation, geographical distribution, and mimicry bearing on the theory of evolution. He has also carried out experimental breeding work on variable protective resemblance, demonstrating the dependence of the coloration of certain larvæ and pupæ on the particular circumstances of their environment. His work was rewarded in 1914 by the Royal Society's Darwin medal.

Early Science at Oxford.

January 25, 1683–4. A letter from Mr. Aston gave an account, of ye specific difference between ye Christalls of Sea-salts and common salt, or Inland salt, which consists in this: The angles of ye Chrystalls of common salt are entire (as likewise are those of *Sal Gemmæ* and ye lixiviated marine salts of Dr. Grew) but ye angles of true sea-salt are cut off, into triangular planes, at least in one of ye sides. Dr. Plot shewed us some Chrystalls of sea-salt, in which we observed ye triangular plane mentioned in Mr. Aston's letter. The severity of ye frost led us then to discourse of cold, particularly of making holes in ye Ice with salt, which eats through ye ice, which means ye common-people make use of, in opening their frozen pumps.

January 26, 1685–6. A paper of Dr. Papin's explaining his new way of raising water was presented and read.

Mr. LLoyd communicated a paper containing an account of some plants, which grow in North Wales, and are omitted in Mr. Ray's catalogue.

Dr. Plot presented an old almanack sent him out of Somersetshire.

January 27, 1684–5. An answer to Dr. Middleton, provost of Kings Colledge in Aberdene, was drawn up, concerning the establishing a Correspondence between us of this Society, and ye Gentlemen of Aberdene.

The Society, being acquainted, that, in Hullington-fields, in Wiltshire, there is an odd sort of light barren earth; and that severall curious plants grow thereabout; gave order, that Dr. Plot, at his return to Oxford, be desired, to write to Mr. Cole of Bristoll, (to whom this land belongs,) and make use of his interest with that gentleman, for ye procuring an account of these matters.

Sir William Petty having thought it worth his while, to enquire into ye proportion of ye materials, used in making severall sorts of Mortar, the following report was drawn up: The Mortar used by our Plaisterers is generally of two sorts, course or ffine: 1. *Course* mortar is made of Lime, sand, and hair. the Lime used here at Oxford is of 2 sorts, viz Chalk-lime, made of a Chalk-stone dug at Nettlebed, and other places, and burnt: or 2dly Hard stone lime, which is made of hard rag stone, burnt; this last sort of lime is much stronger, and will go 2 yards square in five, farther, (for it takes up far greater quantity of sand, and water,) than ye former, which is the finer of ye two, and ye more beautifull, and glorious, to the eye.

One bushell of chalk lime, one bushell of sand, and one peck of hair, mixt all together with water, will make *course* Mortar: but if you use hard stone lime, then one bushell of Lime will require a bushell and ½, or 2 bushells, of sand, and a bushell of hair. In ye making of *fine* mortar mix one bushell of chalk lime with ½ a peck of hair, or a bushell of hard stone lime with a peck of hair, and as much water as is necessary. Course mortar is used next to ye lathing, or ye stone, or brick-wall; ffine mortar is drawn on ye other, makes it white, and beautifull.

Clay mortar, or Loam mortar, is made with clay, and as much chopt straw, as ye clay will take in by ye help of water.

Whiting is made by dissolving Spanish white either in size, or in water, that with size is not easily rub'd off.

That substance, which is commonly sold at London for about 1d. p pound for Spanish white, is supposed to be made of chalk ground, and made up into Balls with water.

Societies and Academies.

LONDON.

Royal Society, January 14.—Leonard Hill and Y. **Azuma**: Effects of ultra-violet radiation upon involuntary muscle and the supposed physiological interference of visible rays. No physiological interference is produced by dark heat or visible rays with the exciting action of ultra-violet on involuntary muscle. The action of ultra-violet rays antagonises that of adrenalin on involuntary muscle, but not that of emetin. The presence of calcium in the nutritive fluid is necessary for the increase of tone produced by ultra-violet rays.—I. de B. **Daly**: A closed-circuit heart-lung preparation; effect of alterations in the peripheral resistance and in the capacity of the circulation. A diminution in capacity of the systemic circulation produces the same effects qualitatively and quantitatively as an increase in the volume of circulating blood, namely, a rise in pressure in both auricles, the aorta and the pulmonary artery, and an increase in the cardiac output. An increase in peripheral resistance has an opposite effect. "Resistance," "capacity" and blood distribution effects are interdependent, their relative effects being determined by the physical constants of the circulation.—C. H. **Best**: On the effect of insulin on the dextrose consumption of perfused skeletal muscle. Insulin greatly accelerates the rate of sugar disappearance from defibrinated blood used to perfuse the isolated limbs of the cat. The action is attributable to its effect on the metabolism of the skeletal muscles.—T. S. P. **Strangeways** and Honor B. **Fell**: Experimental studies on the differentiation of embryonic tissues growing *in vivo* and *in vitro*. (i.) The development of the undifferentiated limb-bud (*a*) when subcutaneously grafted into the post-embryonic chick, and (*b*) when cultivated *in vitro*.—C. N. **Long**: Muscular exercise, lactic acid, and the supply and utilisation of oxygen. Pt. xiv. The relation in man between the oxygen intake during exercise and the lactic acid content of the muscles. In men, as well as in the isolated muscle, the rate of removal of lactic acid, as measured by the oxygen intake, is proportional to the square of the lactic acid concentration in the fluids which are in contact with the muscle fibres. Lactic acid apparently acts as a "governor of oxidation" in the recovery process of muscle.—K. F. **Hetzel** and C. N. **Long**: The metabolism of the diabetic individual during and after muscular exercise. Muscular exercise in the diabetic individual appears to be accompanied by the same metabolic changes as in the normal. Exercise increases the combustion of carbohydrate. For short periods of exercise, with insulin administered during the last 17 hours, the respiratory quotient of the excess metabolism is unity, exactly as in normal men: for exercise of moderate duration its value is intermediate, while for exercise of long duration it tends to fall towards that of the previous resting metabolism. In this respect the diabetic individual with recent insulin, on a diet poor in carbohydrate, behaves in a manner exactly similar to a normal man on a diet consisting mainly of fat, though the phenomena are more exaggerated. In a diabetic individual without insulin, the respiratory quotient of the excess metabolism is always low. It may be supposed that a muscle, for its oxidative processes in recovery from exertion, uses carbohydrate only; that in the presence of insulin there are stores of carbohydrate in a form readily available for use by the muscle, and that a short interval of exercise does not sufficiently deplete these stores to render an immediate restoration necessary from other substances in the body. In the absence of insulin, these ready stores of carbohydrate have run low. Prolonged muscular exertion, a diet poor in carbohydrate, and the absence of insulin, all produce the same effect, namely, a lowering of the respiratory quotient of the excess metabolism due to exercise. All these factors might be expected to deplete the stores of carbohydrate readily available.—W. G. **Millar**: The diffraction method of measuring the diameter of erythrocytes.

SYDNEY.

Royal Society of New South Wales, December 2.—A. R. **Penfold** and R. **Grant**: The germicidal values of some Australian essential oils and their pure constituents, together with those for some essential oils. The published value for terpineol (Rideal-Walker test) is 16. Some other results are: *Atherosperma moschata* (crude oil), 18; formic acid, 5; butaldehyde, 12 (5); butyric acid (normal), 1 (8); butyl butyrate, 13 (17). Figures in brackets are due to either increased or decreased dispersion brought about by solution in alcohol instead of 7·5 per cent. rosin soap solution.—A. R. **Penfold**: The essential oil of *Bæckea Gunniana* var. *latifolia* (F. v. M.). This Myrtaceous shrub is widely distributed throughout the mountains of New South Wales. The yield of oil from the leaves amounted to 0·33 to 0·74 per cent, and its melting-point was 43° to 47° C. It is the only Australian essential oil which has yet been recorded that becomes a solid at ordinary temperatures. It contains more than 60 per cent. eudesmol, eudesmene, b-pinene, small quantities of unidentified phenolic bodies, and valeric acid ester and a stearoptene.—F. A. **Coombs**, W. **McGlynn**, and M. B. **Welch**: The black cypress pine (*Callitris calcarata*, R. Br.) tannins and their distribution in the bark. This tree occurs over a large area of Australia, and possesses a valuable tan-bark containing up to 36 per cent. tannin. Difficulty has been experienced in obtaining a satisfactory commercial extraction, due to regularly recurring bands of cork cells, impervious to water, at close intervals now observed. By grinding the bark to a powder, this difficulty can be overcome. Starch, which is a most important agent in the destruction of tannin when extraction is carried out at high temperatures, was observed in those cells of the inner living bark in which tannin is situated. The bark of this tree is available in large quantities, and is very suitable for the production of a tanning extract. It resembles in many respects the North American hemlock bark, but its tannin content is at least double.—C. A. **Sussmilch**: On the occurrence of waterworn pebbles of coal in the Upper Coal Measures at Red Head, N.S.W. Analysis of one of the pebbles, together with its physical character, indicates a probable derivation from the Greta Coal Seam in the Lower Coal Measures. This indicates that the Lower Coal Measures must have been undergoing denudation during the time that the Upper Coal Measures were being laid down, and therefore, that some crustal movements must have taken place between the deposition of the two coal measures.—Ida A. **Brown**: Some tertiary formations on the south coast of N.S. Wales, with special reference to the age and origin of the so-called "silica" rocks. The flinty quartzites discussed occur on the south coast of New South Wales and in the Ulladulla District, and are quarried as "silica" for use in the manufacture of bricks for lining steel-furnaces. Hitherto they have been regarded as the result of the metamorphism of Upper Marine (Permo-Carboniferous) sandstones by volcanic dykes, but it is considered that they are derived from very pure siliceous sediments of Tertiary age, which have been hardened and compacted by subsequent flows of olivine basalt. Well-preserved fragments of the stems and roots of a dicotyledonous angiosperm were found in the quartzite.

VIENNA.

Academy of Sciences, November 5.—**K. Chudoba**: The dispersion of plagioclase. The gray-position-method has already been applied to determine the situation of the optical axes for different wave-lengths in orthoclase. With albite the dispersion of the B-axis is about three times as great as that of the A-axis. Measurements were made with monochromatic light of six different wave-lengths, and the situation of the axes controlled by the right angle method.—**B. P. Wiesner**: On the function of the germinal gland before puberty; experiments on rats. (I.) Castration of new-born males. The development of sexual characters at puberty is dependent on the endocrine function of the reproductive system. Castration was performed twelve hours after birth, and the after-growth of castrated, one-side castrated, and entire animals compared at various ages. Development continues for a few days only after complete castration; normal and half-castrated animals develop alike. (II.) Spaying of new-born females. In contrast to the males, the normal and spayed females develop alike up to puberty, and only the onset of the œstrus cycle and its periodic recurrence proves the secretory function of the ovary. There is no œstrus in spayed animals, but the earlier stages of the development of sexual characters are independent of the ovary. Details of these researches will appear in *Pflüger's Archiv f. d. ges. Physiologie*.—**P. Weiss**: The morphological impotence of regeneration tissue. The formation of extremities from tail material from Triton. Transplantation was made from the middle of the tail into the body wall near the fore-limb. Various effects took place—healing over, a small tail, warty lumps or a differentiated limb. The regeneration tissue when young seemed to be undifferentiated, and its subsequent growth was determined by the position into which it was transplanted (morphological impotence). Older material, to a certain degree determined as tail, formed tail after transplanting.—**K. Grobben**: Attempt at an explanation of the alternation of layers in pearls.—**H. P. Cornelius** and **M. Cornelius-Furlani**: Report on geological inquiries on the Insubrisch line in the lower Val Tellina. Two quite different zones occur; in the north, highly crystallised biotite-gneiss with intrusions, and in the south, uniform quartz-phyllite.

November 20.—**G. Weissenberger, S. Baumgarten** and **R. Henke**: Absorption by charcoal from viscous media.—**J. Zellner** and others: Contributions to the comparative chemistry of plants, XI. The chemistry of barks. In the barks of Cornus, Tilia and Carpinus, substances have been found such as alnulin, coryliresinol and platanol acid.—**J. Braunhauser**: The chemistry of heterotrophic phanerogams. Mistletoe berries have been analysed.—**A. Huber**: Newton's method of approximation.—**Skrabal** and **A. Zahorka**: The hydrolysis of acetic acid ester by acids.—**J. Pia**: The structure of the Alpine middle-trias deduced from the diplopores.—**H. Handel-Mazzetti**: New Chinese plants (36). Includes species of Aconitum and Corydalis.

November 26.—**K. Umrath**: On the conduction of irritability in Mimosa. In *M. Spegazzinii* as in *M. pudica* there are several stimulus conducting systems. Three velocities of conduction were found in the leaf and two in the stem.—**O. Pesta**: Problems of the hydrobiology in the mountains of the Eastern Alps. Chemical analyses have been made of the waters of mountain lakes.

December 3.—**H. Hahn**: On a theorem of existence in the calculus of variations, and on the method of arithmetical means in the theory of generalised Fourier integrals.—**H. Handel-Mazzetti**: New Chinese plants (37). Three species of Pedicularis are described.

December 10.—**F. Becke** and **J. E. Hibsch**: On nephelines with zonal structure.

Official Publications Received.

Beiträge zur Natur- und Kulturgeschichte Lithauens und angrenzender Gebiete. Herausgegeben von Prof. Dr. H. Stechow. Einleitung, von Prof. Dr. E. Stechow. Vögel, von Dr. H. Sachtleben. (Abhandlungen der math.-phys. Klasse der Bayer. Akademie der Wissenschaften. Suppl.-Band. Einleitung und 1 Abhandlung.) Pp. 222. Steinzeitliche Funde aus Lithauen, von Prof. Dr. F. Birkner. Parasitische Insekten aus Lithauen, von Prof. Dr. Gunther Enderlein. Parasitische Trematoden aus Lithauen, von Dr. L. Scheuring. Biologische Beobachtungen, von Prof. Dr. E. Stechow. (Abhandlungen der math.-phys. Klasse der Bayer. Akademie der Wissenschaften. Suppl.-Band 2-5 Abhandlung.) Pp 223-256+6 Tafeln. Die Zweiflügler der Urwaldes von Bialowies, von Prof. Dr. P. Sack. Hymenoptera (Aculeata, Ichneumonidae, Chalastogastra), von Dr. H. Bischoff. Trichopteren und Ephemeropteren aus dem Bialowieser Wald, von Dr. G. Ulmer. Über Waldbienenzucht in Lithauen und einigen Nachbargebieten, von Dr. H. Klose. (Abhandlungen der math.-phys. Klasse der Bayer. Akademie der Wissenschaften. Suppl.-Band. 6-9 Abhandlung.) Pp. 257-406+9 Tafeln. (München: Verlag der Bayerischen Akademie der Wissenschaften.)

U.S. Department of Agriculture: Weather Bureau. W.B. No. 866: Instructions to Marine Meteorological Observers. (Circular M, Marine Division, Fourth edition.) Pp. x+90+8 plates. (Washington: Government Printing Office.)

Transactions of the Royal Society of Edinburgh. Vol. 54, Part 2, No. 5: Studies in Irregular Nutrition. No. 1: The Parasitism of Cuscuta reflexa (Roxb.). By John Thomson. Pp. 343-356+8 plates. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.) 4s. 6d.

The South-Eastern Naturalist: being the Thirtieth Volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Thirtieth Annual Congress, held at Folkestone, 1925. Edited by A. F. Ravenshear. Pp. lxxxii+136. (London.)

Ministry of Public Works, Egypt: Physical Department. The Lake Plateau Basin of the Nile. By Dr. H. E. Hurst. (Physical Department Paper No. 21.) Pp. vi+75+41 plates+12 charts. (Cairo: Government Publications Office.) 10 P.T.

Proceedings and Transactions of the Croydon Natural History and Scientific Society. Vol. 9, No. 4, February 1923 to January 1925. Pp. xxxiii-xlix+38+187-224+50. (Croydon.) 5s. net.

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 20: Statistics of Kindergartens 1923-24. Pp. ii+7. (Washington: Government Printing Office.) 5 cents.

United States Department of Agriculture. Farmers' Bulletin No. 789: Mushroom Pests and How to Control Them. By C. H. Popenoe. Pp. ii+6. (Washington: Government Printing Office.) 5 cents.

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 1924-25. Vol. 69. Pp. 102+xlii+viii. (Manchester.) 12s.

Report of the Institute for Science of Labour, July 1921–June 1925. Pp. ii+35+2 plates. (Kurashiki, Japan.)

Aeronautical Research Committee. Reports and Memoranda, No. 980 (Ae. 196): The Rolling and Yawing Moments of an Aerofoil in Straight Flight. By H. Glauert. (A.2.a. Aerofoils—general, 152—T. 2105.) Pp. 5. (London: H.M. Stationery Office.) 3d. net.

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Supplement to the Minutes of Proceedings of the Institution. Edited by W. F. Spear. New Series, No. 25, October. Pp. 280. (London.)

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 36, Part 4. Pp. 371-462. (London: E. Stanford, Ltd.) 5s.

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September 1925. Pp. 24+5 plates. (Bristol.)

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 14: Regenval in Nederlandsch-Indie (Rainfall in the Netherlands Indies). Door (by) Dr. J. Boerema. Deel 2 (Vol. 2). Kaarten van den gemiddelden jaarlijkschen en maandelijkschen regenval op Java en Madoera, met een kaart der regenstations (Maps of the Mean Yearly and Monthly Rainfall on Java and Madoera, with a Map showing the Position of the Rainfall Stations). Pp. ii+14 Maps. (Weltevreden: Landsdrukkerij.)

Department of Agriculture, Ceylon. Bulletin No. 73: Import of Fertilizers into Ceylon. By Alexander Bruce. Pp. 41. (Peradeniya.) 40 cents.

Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau), 1924-25. Pp. v+168. (Calcutta: Government of India Central Publication Branch.) 2.4 rupees; 4s.

Annuaire de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, 1925. (91e année.) Pp. 265+8 plates. (Bruxelles: Maurice Lamertin.)

Government of India: Department of Industries and Labour, Public Works Branch. Triennial Review of Irrigation in India, 1921-1924. Pp. ii+71. (Calcutta: Government of India Central Publication Branch.) 1 rupee; 1s. 9d.

Diary of Societies and Public Lectures.

SATURDAY, JANUARY 23.

British Mycological Society (at University College), at 11 A.M.—B. Barnes: Preliminary Observations on the Physiology of *Lachnea*.—A. Chaston Chapman: A Plea for a National Institute of Industrial Micro-Biology.—Kodak Ltd.: The Eastman Colorimeter.—J. Ramsbottom: Fragmenta Mycologica V.—G. Tandy: Cytology of *Pyronema domesticum*, Sacc.—W. M. Ware: *Pseudoperonospora Humuli*, Miyabe and Tak, and its Mycelial Invasion of the Host Plant.

Electrical Association for Women (at Æolian Hall), at 3.—Demonstration of the Application of Electricity in the Production of Music for the Home.—H. V. Spanner: The Place of Music in the Home (Lecture).

Royal Institution of Great Britain, at 3.—H. Balfour: The Evolution of Currency and Coinage.

Physiological Society (at National Institute for Medical Research).

MONDAY, JANUARY 25.

Royal Irish Academy, at 4.15.

Royal Society of Edinburgh, at 4.30.—Prof. T. J. Jehu and R. M. Craig: Geology of the Outer Hebrides. Part 2, North Uist and Benbecula.—Dr. P. M. Finlay: The Old Red Sandstone of Shetland. Part 1, Eastern Area. With Notes on the Fossil Fishes of the Old Red Sandstone of the Shetland Islands. By Sir A. Smith Woodward and E. I. White.—Prof. J. K. Charlesworth: (*a*) The Great Re-Advance Kame-Moraines of the South of Scotland, and some Later Stages of Retreats; (*b*) The Glacial Geology of the Southern Uplands of Scotland, West of Annandale and Upper Clydesdale.—Dr. A. E. M. Geddes: The Distribution of Electric Force in High Voltage Discharges.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—Lt.-Commdr. V. L. Trumper: Modern Science in the Book of Job.

Institute of Actuaries, at 5.—C. F. Warren: An Investigation into the Mortality experienced by Pensioners of the Staffs of Banks and Insurance Companies, with a Note on the Mortality experienced by Deferred Annuitants.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Fossil Remains of Ape and Man (4). The Taungs Anthropoid: its Zoological and Geological Position.

Royal Society of Medicine, at 5.—Lord Dawson of Penn and others: Discussion on Hyperpiesia.

Institution of Electrical Engineers (Informal Meeting), at 7.—Discussion: Impressions on my Visit to America, mainly about Switchgear.

Institution of Electrical Engineers (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Capt. P. P. Eckersley: The Past, Present, and Future of Wireless Telephony.

Royal Society of Arts, at 8.—H. P. Shapland: The Decoration of Furniture (Cantor Lectures) (2).

Royal Society of Medicine (Odontology Section), at 8.—A. W. Wellings: Some Points in the Anatomy of the Capillaries of the Tooth Pulp.—W. Harrison and E. W. Lowe: Notes of a Complicated Removal of a Third Lower Molar—Fatal Sequel.

Royal Geographical Society (at Æolian Hall), at 8.30.—H. J. L. Beadnell: Recent Travels in Central Sinai.

Medical Society of London, at 8.30.—R. C. Elmslie, W. R. Bristow, and others: Discussion on Manipulative Treatment in Medicine and Surgery.

TUESDAY, JANUARY 26.

Royal Dublin Society (at Ball's Bridge, Dublin), at 4.15.—Prof. F. E. Hackett and others: Discussion on Recent Theories of Stellar Evolution.

Royal Institution of Great Britain, at 5.15.—Prof. J. A. Crowther: X-rays and Living Matter (2).

Institution of Civil Engineers, at 6.—A. S. Angwin and T. Walmsley: Rugby Radio Station.

Institute of Marine Engineers, at 6.30.—F. A. Best: The Flettner Rudder.

Institution of Automobile Engineers (Informal Meeting) (at 83 Pall Mall), at 7.—Discussion on Tire Pumps and Jacks.

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—L. H. A. Carr: The Use of Induction Regulators in Feeder Circuits.

Royal Photographic Society of Great Britain, at 7.—A. S. Newman: Three Fallacies in Kinematography.

Institution of Engineers and Shipbuilders in Scotland (at 39 Elmbank Crescent, Glasgow), at 7.30.—G. J. Lugt: The Werkspoor Diesel Engine.

Royal Anthropological Institute, at 8.30.—Anniversary Meeting.

Royal Society of Medicine (Medicine and Comparative Medicine Sections), at 8.30.—Sir Humphry Rolleston (Medicine), Prof. Wooldridge (Comparative Medicine), and others: Discussion on Hodgkin's Disease in Man and Animals.

Institution of Electrical Engineers (Western Centre) (South Wales Institute of Engineers, Cardiff).—A. P. Trotter: Illumination and Light (Faraday Lecture)

WEDNESDAY, JANUARY 27.

Leeds Philosophical Society, at 5.

Royal Society of Medicine (Comparative Medicine Section), at 5.—Prof. R. H. A. Plimmer: The Relation of Quantity of Vitamin B to Quantity of Food.—Prof. J. C. Drummond: New Facts concerning the Fat-soluble Vitamins.

Royal College of Surgeons, at 5.—Sir Arthur Keith: Fossil Remains of Ape and Man (5) Fossil Anthropoids of Europe and of Asia.

Newcomen Society for the Study of the History of Engineering and Technology (at 17 Fleet Street), at 5.30.—D. Brownlie: John George Bodmer, his Life and Work, particularly in the Evolution of Mechanical Stoking.

Radio Society of Great Britain (at Institution of Electrical Engineers), at 6.30.

Institution of Electrical Engineers (South Midland Centre) (at Birmingham University), at 7.—C. E. Webb: The Power Losses in Magnetic Sheet Material at High Flux Densities.

Institute of Metals (Birmingham Local Section) (jointly with Birmingham Metallurgical Society) (at Temperance Hall, Temple Street, Birmingham), at 7.—W. R. Barclay. Metallurgy of Nickel with Special Reference to Work in Canada

Institution of Automobile Engineers (North of England Centre) (at 244 Deansgate, Manchester), at 7.15.—J. D. Parkes: Logic applied to Failures.

Glasgow University Alchemists' Club (jointly with Andersonian Chemical Society), at 7.30.

Institute of Chemistry (Edinburgh and East of Scotland Section) and Society of Chemical Industry (Edinburgh and East of Scotland Section) (at 36 York Place, Edinburgh), at 7.30.—Dr. A. E. Dunstan: Recent Developments in the Refining of Petroleum.

Royal Society of Arts, at 8.—Prof. J. McLean Thompson: Some General Problems of the Transport by Sea and Conservation in Store of Ripe Fruit (Aldred Lecture).

Eugenics Education Society (at Royal Society), at 8.30.—Prof. F. G. Parsons: The Earlier Inhabitants of London.

British Psychological Society (Medical Section) (at Royal Society of Medicine), at 8.30.—Dr. M. Culpin: Investigations into the Predisposition to Breakdown.

THURSDAY, JANUARY 28.

Royal Society, at 4.30.—Prof. A. C. Seward: The Cretaceous Plant-Bearing Rocks of Western Greenland.—Dr. W. L. Balls and H. A. Hancock: Measurements of the Reversing Spiral in Cotton Hairs.—R. H. Burne: A Contribution to the Anatomy of the Ductless Glands and Lymphatic System of the Angler Fish (*Lophius Piscatorius*).—I. Gordon: The Development of the Calcareous Test of *Echinus miliaris*.—*To be read in title only*:—F. G. Gregory and L. Batten: A Critical Statistical Study of Experimental Data on the Effect of Minute Electric Currents on the Growth Rate of the Coleoptile of Barley.—H. M. Fox: Chlorocruorin: a Pigment allied to Hæmoglobin.

Royal Institution of Great Britain, at 5.15.—Prof. C. J. Patten: The Breeding Factor in Birds.

Institute of Chemistry Students' Association (London) (at Institute of Chemistry), at 8.—G. Lemoneus: The Transference of Chemical Processes to the Large Scale (Address).

FRIDAY, JANUARY 29.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Fossil Remains of Ape and Man (6). The Kivu Gorilla and its Bearing on the Problems of Human Evolution.

Institution of Structural Engineers (Yorkshire Branch) (at Great Northern Hotel, Leeds), at 6.30.—D. Davidson: A New System of Reinforced Concrete Construction and its Application to Foundations on Silt and Running Sand.

Junior Institution of Engineers, at 7.30.—A. N. Moon: Comfort in Railway Travel from the Point of View of the Engineer.

Royal Institution of Great Britain, at 9.—Sir William B. Hardy: On Films.

Manchester Literary and Philosophical Society.

SATURDAY, JANUARY 30.

Royal Institution of Great Britain, at 3.—H. Balfour: The British Coracle, or Skin-covered Boat, and its Affinities.

North of England Institute of Mining and Mechanical Engineers (Associates' and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 5.—P. F. Hope: The Sinking of Monkton Shaft.—J. T. Pringle: Housing of Workmen (Discussion).

Institute of Metals (North-East Coast Local Section) (jointly with Institution of British Foundryman) (at Neville Hall, Newcastle-upon-Tyne), at 6.15.

PUBLIC LECTURES.

SATURDAY, JANUARY 23.

Horniman Museum (Forest Hill), at 3.30.—Miss M. A. Murray: Europe's Debt to the Ancient Egyptians.

MONDAY, JANUARY 25.

University of Leeds, at 5.15.—Prof. G. Watson: Approximations.

King's College, at 5.30.—Dr. F. A. P. Aveling: The Human Will: Medieval Views.

University College, at 6.—H. D. J. White: Psychology of Art: Beauty and the Unconscious.

TUESDAY, JANUARY 26.

University College, at 5.30.—Miss M. A. Murray: Egyptian Architecture.

SATURDAY, JANUARY 30.

Horniman Museum (Forest Hill), at 3.30.—H. Harcourt: Glimpses of Indian Places and Peoples.

CONFERENCE.

WEDNESDAY, JANUARY 27.

Rothamsted Experimental Station, Harpenden, at 11.30 A.M.—The Growing of Lucerne. Chairman: Lord Clinton. Speakers: Sir E. J. Russell: Spread of Lucerne Growing.—Prof. R. G. Stapledon: Lucerne in High and Wet Districts.—J. Mackintosh: Lucerne for the Dairy Farmer.—A. Cunningham: Scottish Experiments with Lucerne.—H. G. Thornton: Inoculation of Lucerne.

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Electric Supply in Great Britain.

UNTIL the details of the Government electric supply scheme for Great Britain outlined by Mr. Baldwin on January 15 are published, it is only possible to discuss the scheme in a general way. It may be useful, however, to give a brief survey of the conditions affecting electric supply in Britain. The proposals are of national interest, affecting directly not only the electrical industry but also the many industries for which electric power is a necessity. They also affect every one who uses or in the future may use electricity for domestic purposes.

Situated all over the country are 584 public supply stations. A few of these are large and highly efficient, but several are getting antiquated. They are operated by private companies, municipalities and "joint authorities" in accordance with the Electric Lighting Act of 1919. Some of these are authorised to supply electricity in bulk, and these will retain their powers. After the electricity is generated it is transmitted to distributing stations, where the business of the engineers is to make arrangements for supplying consumers with electric power and light. The scheme is to eliminate gradually the inefficient generating stations and convert them into distributing stations. They will purchase their electricity in bulk from a central board, which will own a huge distributing network of mains. This board will purchase its electricity from a selected number of existing generating stations, and after paying the small expenses of management and the interest and sinking fund on its network, will apply any surplus to the cheapening of the cost to the consumer.

The scheme is not exactly novel, as a somewhat similar one was suggested for Great Britain and discussed in the electrical press last year. It seems, however, to have been studied in detail by the Electricity Commissioners, who approve of it. It will be useful, therefore, to consider the beginnings of electric supply in Great Britain and to discuss some of the problems that will want careful consideration. There will be no Government subsidy, but the interest on the capital required to purchase the transmitting mains and to pay for the cost of their erection will be guaranteed by the Government under the Trade Facilities Act.

The evolution of the method of supplying electricity over considerable distances was started by Ferranti about forty years ago. He designed a station at Deptford for generating electrical energy at 10,000 volts and transmitting it to substations in London, where it was transformed down to lower pressures and distributed to consumers. The site was chosen in a place where there was abundant water for condensing purposes and where coal was cheap owing to the low costs of transport. The late Lord Crawford was very enthusiastic over the scheme and was one of its strongest supporters. It needed great courage and great faith in science in those days to undertake such an experiment. It is interesting to remember that it is this station which supplies the power required by the Southern Railway to work its electrified sections. Ferranti is universally recognised as the pioneer of modern electric supply. The Government legislation of this period made electric supply very difficult. London was divided up into small areas, each of which was to be supplied by two companies, one using direct current and the other alternating current, the idea being that the competition between the two would tend to cheapen the supply. Under such conditions, it is surprising that any company survived, seeing that security of tenure was only given for a limited number of years.

In 1919, only seven years ago, the Government again introduced legislation affecting the industry. The country was divided up for electrical purposes into a number of districts, each of which was practically autonomous, and powers were given for the erection and working of large generating stations by joint authorities. The new scheme considers that England is not too large to be considered as a single unit, the generating, transmitting and distributing parts of the industry being kept quite distinct. It has been very cleverly arranged that the new scheme will gradually come into operation with the minimum disturbance of existing arrangements, and yet, in ten or fifteen years' time, the great bulk of the public who use electricity will be supplied at very much cheaper rates.

At first sight, we picture this national system of transmitting lines as extending from Land's End to Thurso, and from Glasgow to Newcastle, Birmingham and London. To diminish the cost of transmission, if not 220,000 at least 110,000 volts must be used. A little consideration, however, will show that the cost of the mains required in this case would be altogether prohibitive. Still we consider that in ten years' time the length of the lines necessary to link up all the centres of supply will be at least 2000 miles and the cost of overhead mains would be at least 6,000,000*l*. It has also to be remembered that there will be a heavy additional expenditure at the distributing end of the mains due to the rotary converters or mercury arc rectifiers which would probably be used to lower the pressures and convert the alternating current supplied into direct current.

It will be seen that a national transmission network can only be erected at a very great capital cost, and interest, depreciation and maintenance will be very heavy items. But we think that, provided the scheme is not rushed unduly but allowed to develop gradually, it is a good and sound commercial proposition. In any case, owing to the Government guarantee, we think that the requisite capital will easily be obtained. It has been suggested that it may be possible in the future to transmit electric power through the ether without transmission cables at all. With our present knowledge of science, however, this suggestion, like the corresponding one of obtaining energy from the atom, need not be seriously considered for many years to come.

In our opinion, Mr. Baldwin perhaps laid unnecessary stress on the standardisation of the frequency. Most electricians agree that 50 should be the standard frequency and that every new station should have this frequency, but there is no urgent necessity for scrapping the existing generators and apparatus which work at other frequencies. It is a very simple operation to link two networks together by suitable synchronous motor-generator sets so that power can be transformed from one to the other quite easily.

This national network will provide a large number of problems for mathematical engineers. In Great Britain, hitherto, it has been permissible to assume that the capacity and inductance of the mains can be supposed to be concentrated at particular points of the mains. In the future, this assumption will seldom be admissible as the networks will be large and hyperbolic sines and cosines will have to be used in making the requisite calculations. Again it will not be sufficient to assume that the most economical site is the centre of gravity of the load. Lengthy calculations will have to be made, and the problem of finding which site is the best will have to be investigated much more minutely in the future than in the past. Competent mathematicians should be in great demand.

Unfortunately, there is not yet a 1,000,000 volt testing transformer at the National Physical Laboratory for testing the high voltage insulators which will have to be used. Progress in this direction should be accelerated. The physics of the brush discharges, generally called the corona, which appear sometimes on high tension mains, have been thoroughly investigated in the United States.

Mr. Chattock, in his presidential address to the Institution of Electrical Engineers, pointed out that it would be very difficult to supply rural districts at a reasonable rate by tapping the high tension mains directly, as this is always a costly process. The connexions would have to be made at well-defined centres, from which light overhead wires carrying currents at low pressures would radiate in all directions. The present high price of wiring cottages in rural England for the electric light is due to the very stringent regulations under which wiring contractors have to work. On the Continent, the cost is only about a third or a quarter of what it is in England. There is a considerable margin, therefore, for reducing the price of wiring by lowering the pressure of supply sufficiently so that much less stringent regulations could be used.

We hope that something will be said in the promised Bill about electrifying the railways and equipping every coal mine in the country with complete electrical plant for getting the coal and for pumping and ventilating. Expenditure of this kind is immediately remunerative, and the Government guarantee would help to foster what the Americans call " public utility " services.

One great advantage of interlinking supply stations is that the supply of reserve plant will be largely reduced. The Electricity Commissioners have stated that 68 per cent. of the generating plant in Great Britain is normally idle. We were glad that the Prime Minister in his speech laid stress on the necessity of educating the public to the many domestic uses to which electricity can be put. The demand is certain to increase as the points of supply are multiplied and the price per unit reduced. It can nearly always be used economically for cooking and in many cases for heating. If the price of electricity be sufficiently reduced, chimneys will be a relic of barbarism. This Bill should give electrical engineers a great opportunity of showing how greatly they have benefited by the scientific and technical researches carried out since the War. The maximum water power available to us is only about a tenth that required for our industrial needs. Looked at from the electrical point of view, Britain is a very compact country with plenty of fuel available for many years to come. We look to our engineers to control the forces of Nature to further the welfare of the nation.

The Life of the Salmon.

The Salmon: its Life Story. By W. J. M. Menzies. Pp. xii+211+36 plates. (Edinburgh and London: William Blackwood and Sons, 1925.) 21*s.* net.

PROBABLY there is no vertebrate animal, except the eel, whereof the secret of its life-history has yielded so recently to systematic observation and research as the Atlantic salmon. Just as in 1896 Battista Grassi succeeded in demonstrating that the small marine fish previously classed as Leptocephalus was none other than the alevin of the eel, so in 1840 did John Shaw, gamekeeper at Drumlanrig, by confining a number of parr, hitherto accorded specific rank by ichthyologists as *Salmo salmulus*, prove that they assumed the seasonal smolt livery before being released to descend to the sea, whence they should return as *Salmo salar*.

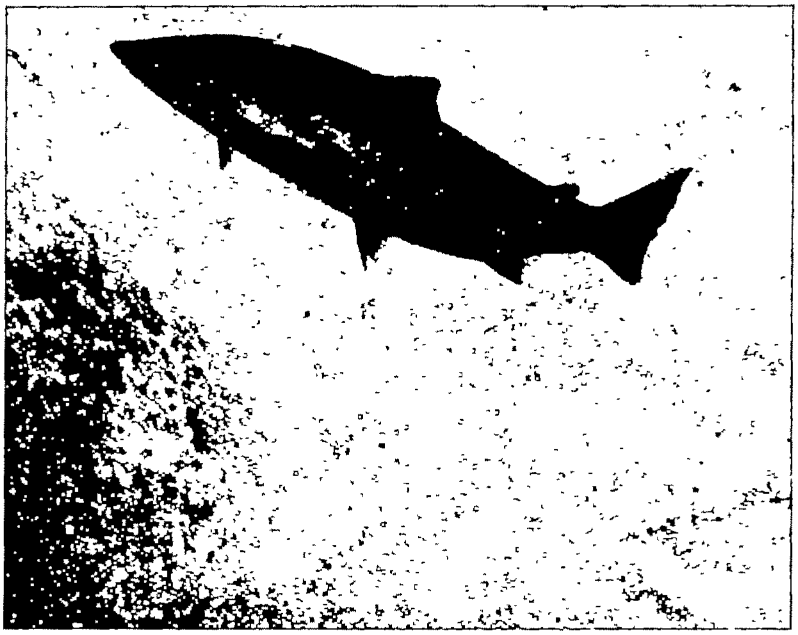
FIG. 1.—Salmon jumping at Ballyshannon Falls, R. Erne, Ireland. From "The Salmon: its Life Story."

That marked an important advance in our knowledge of one of the most valuable food-fishes; but many years passed without any further progress being reported. So late as 1886 we may read in the ninth edition of the "Encyclopædia Britannica" a statement that the smolts increase so rapidly in size after reaching the sea that they return *in the same year* as sexually mature salmon. "It is surprising," is the writer's naive comment, "that a smolt weighing only a few ounces should increase to 3 or 4 or even 6 lb. in about three months."

It was not until 1904 that Mr. H. W. Johnston announced his discovery that the age of every salmon was automatically registered on the hyalo-dentine surface of every scale on its body. This fresh light, combined with the result of marking some 6500 smolts in the Tay, as undertaken jointly by Mr. Calderwood, Salmon Fishery Inspector for Scotland, and the late Mr. P. D. Malloch of Perth, followed by the recapture of a small percentage of the marked fish on their return to the river, has redeemed from all doubt the chief facts in the life-history of the salmon. The conclusions registered have been confirmed by observations in many other rivers, notably by those conducted by Mr. J. Arthur Hutton in the Wye of Hereford.

In "The Salmon: its Life Story," Mr. W. J. M. Menzies has undertaken to summarise these conclusions and to describe for the general reader the method by which they were attained. As Assistant-Inspector of Scottish Salmon Fisheries, he has borne an active part in the marking and recapture of salmon and in registering the results. His narrative is enriched by incidents of independent observation and illustrated by many photographs. Among the latter must be noted one serious omission, namely, that in none of the numerous figures of salmon scales is there any indication of scale in another sense, although all are shown many times larger than life. This is specially perplexing, because the illustrations of smolt scales are not made from scales taken from smolts, but represent only the central portion of the scales of adult fish.

The scales of a salmon do more than merely registering its age and periodical intervals of fasting; the spawning crisis also is indicated by the peculiar scar which may be seen four times repeated in Fig. 2. Recognition of the spawning scar has revealed the fact that, although salmon may and do spawn as grilse and at any subsequent age, it is but a small percentage that do so more than once.

"Investigations in the east coast rivers, as well as in catches taken in the coast nets, have shown that in the total catch of the season the proportion of previously spawned fish is very seldom more than 5 per cent., and, on occasion, may be less than 2 per cent. The exact proportion varies from year to year, but in general is in the neighbourhood of 4 per cent."

Observation on this point has been chiefly conducted hitherto on the east coast of Scotland. Such investigation as has been effected on the western seaboard indicates a much larger percentage. It was found that among the large number of salmon taken in the Add of Argyll, no less than 34 per cent. had previously spawned. The effort of spawning greatly exhausts the fish, far more among the males than the females, the majority of the former dying before reaching the sea. The spawning mark on the scales is caused by the total absorption of the margin of the scale, during the sojourn in the river, the whole muscular fabric of the fish being also seriously depleted and deteriorated. It is remarkable that simultaneously with this depletion, the jaws of the male salmon should be greatly prolonged, a great hook being formed on the lower jaw fitting into a corresponding socket in the upper jaw. The purpose of this peculiar growth has been the subject of much speculation without any approach to explaining it.

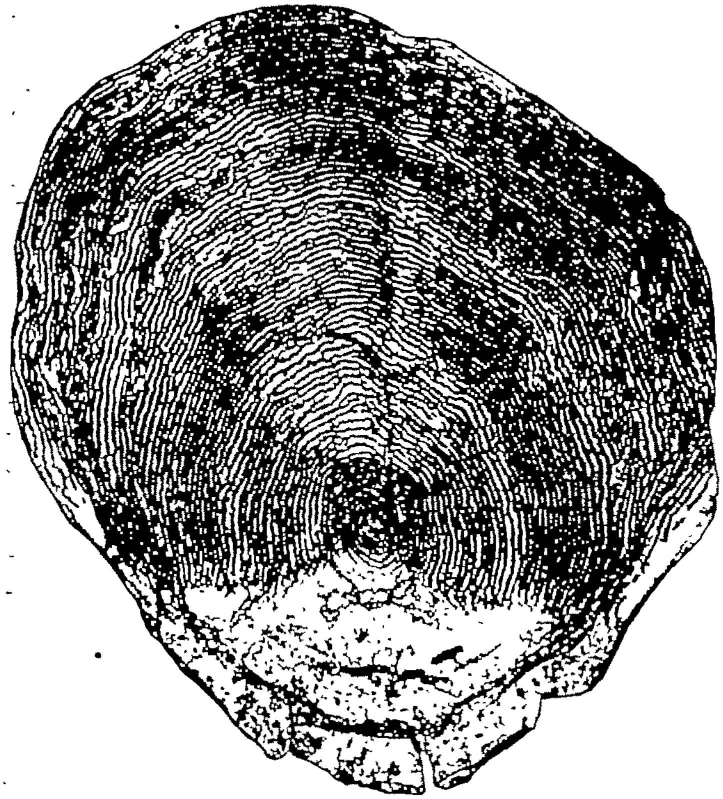

FIG. 2.—Scale of a salmon which spawned four times. From "The Salmon: its Life Story."

No question is more frequently—often hotly—discussed among anglers than whether the salmon feeds in fresh water after its return from the sea. As a parr, of course, it has to rely upon river fare; but rivers, especially Scottish rivers, provide no food sufficient to nourish lusty adult salmon, which, it must be remembered, frequented them in incalculably greater numbers before the stock had become decimated by netting and other modes of capture. Like every other scientific observer, Mr. Menzies holds strongly the opinion that a salmon fasts as soon as it leaves the sea, often, indeed, before doing so if hindered by drought or other impediment. Among other instances he quotes the result of investigation conducted in the Tweed, where it was found that out of 1442 salmon taken in the estuary, 128 (9 per cent.) contained remains of food in their stomachs, whereas none among 257 taken higher up the river retained any trace of food in stomach or intestine. It may be long before fishermen will agree in acquitting hungry-looking kelts of cannibalism; it will be longer still before suspicion will be confirmed by discovering remains of food in their stomachs or intestines.

Mr. Menzies has contributed a most useful and convenient review of the recent advance in knowledge of the life-history of the salmon, rendered possible by Mr. Johnston's discovery and interpretation of scale-marks and carried into effect by the systematic vigilance of the Fishery Board of Scotland.

HERBERT MAXWELL.

A New Survey of Architecture.

Architecture. By Sir Thomas Graham Jackson. Pp. xi + 366 + 111 plates. (London: Macmillan and Co., Ltd., 1925.) 25*s.* net.

THIS compact and well-produced volume on the growingly popular subject of the art of building is the work of no less an authority than the late Sir Thomas Jackson, Bart., R.A. The manuscript, fortunately, was completed before his death, and this posthumous book is the last from his facile pen. It is stated in the preface that "it is hoped that the book may act as an incentive" to the reading of his greater works, "Byzantine and Romanesque Architecture," "Gothic Architecture," and "The Renaissance of Roman Architecture."

The work differs from a text-book in the ordinary sense, for it is not a complete study of past art; it does not profess to be a history of architecture pure and simple. It is in no way a general essay on architecture, and though larger than a handbook is less comprehensive than a text-book; it is rather a critical study and summary of special periods, and is of a suggestive nature, which should stimulate thought and study. The work of the ancient nations of Egypt, Mesopotamia and Persia is practically omitted, and very little is said even as to the Greek and Roman styles; one chapter suffices to deal with the earlier work of each. It concentrates chiefly upon the subjects treated in the author's earlier works. It is a searchlight thrown upon certain phases of architecture.

This pleasant book is written in an easy narrative manner—a method of treatment which is all the more noticeable when a number of more or less independent styles and buildings are dealt with in rapid succession. It should convey, even to a reader little acquainted with the subject, a clear and comprehensive idea of the best buildings of the different types discussed. The illustrations, which include excellent half-tone photographs and some characteristic sketches by the author, with a few plans and elevations, are well distributed throughout the letterpress. The author has recognised that even in a general summary it is essential to show the structural motives and principles of building, before the external or internal design can be appreciated; this is clearly shown by the brief but helpful explanations of constructional expedients, such as the use of "orders" or rings of an arch in Romanesque and the construction of the vault in Gothic architecture.

Perhaps the most interesting features of the book, however, are the critical essays forming the introduction and epilogue. In the former the vexed question, "What is Architecture?" is courageously considered, and the author insists again that the true nature of architecture "does not consist in beautifying building, but on the contrary in building beautifully, which is quite another thing."

In a new work one looks to see what is said as to loubtful or disputed matters, and in this connexion it is nteresting to find that the pointed arches at Fountains Abbey and Worcester Cathedral are quoted as among he earliest in England, while the famous pointed vault at Durham is relegated to a date twenty-five years later han has been commonly assigned to it. There would appear to be few errors of fact, but the Parthenon plan should show solid walling between naos and Parthenon proper, as the openings, according to Prof. E. A. Gardner, were not part of the original design. Again, he plan of Westminster Abbey attributes the ritual hoir, or eastern part of the structural nave, to the eign of Edward I. instead of to the later years of Henry III. (1260–69). The chronological chart, showng the chief buildings in the different countries arranged n parallel columns, is useful, and there is a good index, ut no glossary.

In conclusion, it may be said that this work on rchitecture has a certain character all its own, which lly justifies its publication. One book may have a echnical, another a social, and another a religious bias, ut this is distinctly human in nature in its treatment f monarchs, patrons and architects who have played their part in the architectural drama. The epilogue is suggestive, in its description of all architecture as either "bond" or "free"—that is, either rigidly confined to a prescribed formalism, or freely adaptable to the genius of the individual. It is clearly emphasised that it depends on this generation to determine the quality of the architecture of the immediate future, and to have a care that the architectural needs of our time are met, in the words of the author, not by "beautifying building" but by "building beautifully," so that the art of man may go hand in hand with Nature in producing beautiful effects.

BANISTER FLETCHER.

Higher Geometry.

(1) *Principles of Geometry.* By Prof. H. F. Baker. Vol. 4: Higher Geometry; being Illustrations of the Utility of the Consideration of Higher Space, especially of Four and Five Dimensions. Pp. xvi + 250. (Cambridge: At the University Press, 1925.) 15*s.* net.

(2) *Géométrie du compas.* Par A. Quemper de Lanascol. Pp. xx + 406. (Paris: Albert Blanchard, 1925.) 24 francs.

(1) IN 1873 Darboux published his interesting book, "Sur une classe remarquable de courbes et de surfaces algébriques," in which he obtained properties of bicircular quartics, including as particular cases Cartesian ovals, the limaçon and the cardioide, by projection from the curve of intersection of two quadrics. But going on to the corresponding properties of quartic surfaces with a double conic, the cyclides and the anchor-ring, he found it necessary to remark: "Comme on n'a pas d'espace à quatre dimensions, les méthodes de projection ne s'étendent pas à la géométrie de l'espace."

The day has now long gone, we hope, since it was necessary to avoid the use of space of more than three dimensions in order to obtain results in ordinary space; at any rate, Prof. Baker's fourth volume will convince any one of the enormous power of the method. To obtain, from a single configuration in four dimensions, and that so simple, four arbitrary straight lines or, alternatively, six arbitrary points, practically all the surfaces and constructs about the properties of which anything at all is known, the Kummer surface, the Weddle surface, the tetrahedral complex, etc., is surely a remarkable achievement. Again, the quadric in five dimensions, as remarked by Cayley and Klein and examined in more detail by Segre, gives an immediate and much simplified account of that somewhat complicated discipline "line geometry."

The method of projection from higher space can, of course, be applied to more elementary theorems.

Propositions of one-dimensional geometry, of ranges of points upon a straight line, can be made simpler and less algebraical by considering the line as derived by projection from a conic, or, more generally, from the normal curve of order n in space of n dimensions. Circle geometry in the plane, with all its complication and apparent haphazardness, appears as an ordered whole when regarded as obtained by projection from the geometry of plane sections of a quadric. The reviewer well remembers his astonishment when it was first pointed out to him, in lecture, that Wallace's theorem of the common point of intersection of the four circumcircles of the triangles formed by four straight lines was essentially the same, from this point of view, as the theorem about Möbius tetrads, mutually inscribed and circumscribed—a proposition involving only points, lines, and planes. Also the theorem of the Hart circle of three given circles, which is such that the four circles are all touched by four other circles, becomes much more interesting and instructive in three dimensions.

All this, and very much more, is packed into the 244 pages of this volume. The book naturally suffers from the compression and is not one to be read in an arm-chair; indeed, any one page will furnish matter for several hours' cogitation by the ordinary mortal. But it is a fascinating study, and British mathematicians may well be proud of such a splendid mine of geometrical lore as is to be found in the four volumes of "Principles of Geometry."

(2) The "Géométrie du compas" of M. Quemper de Lanascol is a book of quite another kind. There is a mathematical interest in showing that every geometrical problem which can be solved by ruler and compasses can be solved by compasses alone, but this is not a difficult matter. One has only to show that (*a*) the point common to two straight lines and (*b*) the points common to a straight line and a circle, where a straight line is given by two of its points, can be found without a ruler and the thing is done. Alternatively, one can proceed by the method of Adler, by showing how to find with compasses only the inverse of a point with respect to a given circle, and remarking that we have then only to invert the ordinary construction with ruler and compasses, which involves straight lines and circles, to get a construction involving circles only. For an adequate account of both methods reference may be made to the article by E. Daniele in "Questioni riguardanti le matematiche elementari" (1914), t. 2, pp. 25-48; Coolidge in his "Treatise on the Circle and the Sphere" does the whole thing in a couple of pages (pp. 187-8).

But Mascheroni, whose "Geometria del compasso" (Pavia, 1797) is the *locus classicus* of the subject, did not confine himself to the theoretical aspect. He maintained that the practical difficulties of making a perfectly straight edge rendered it important to avoid the use of such an instrument, and his book is filled with ingenious constructions, as simple as may be, for all the problems of elementary geometry, obtaining each point of the figure as an intersection of two circles. He also gave approximate constructions, by the same means, for problems of higher than the second degree and for transcendental problems, the duplication of the cube, the quadrature of the circle, and so on.

The present volume contains all that is in Mascheroni and, in addition, gives a section on inversion. The material has been rearranged, much new matter has been added, from various sources, and the result is a great improvement on the prolixity of the "bon abbé." The book will appeal to the mathematical amateur who delights in what the author deprecatingly terms "une sorte d'acrobatie géométrique," especially when he reads how Napoleon lectured his band of savants on this very subject, evoking from Laplace the remark: "Nous attendions tout de vous, général, sauf des leçons de mathématiques." F. P. W.

Our Bookshelf.

Male Infibulation. By Eric John Dingwall. Pp. vii + 145. (London: John Bale, Sons and Danielsson, Ltd., 1925.) 10*s*. 6*d*. net.

THIS work is the first volume of a series which the author is undertaking in connexion with some of the more obscure customs of antiquity and the Middle Ages related to the sexual life of man. The book consists of three chapters dealing respectively with three forms of the practice to which the term infibulation has been applied, namely, the Roman form, the Greek form, and phallus curvatus. In the Roman form, where alone the term is applicable, a ring or similar object is attached to the prepuce. The operation was chiefly performed on singers, musicians, and slaves, the principa object being to preserve the quality and tone of the voice, which was supposed to be corrupted by sexual indulgence, while the subsidiary reason was to preven masturbation. In the Greek form, which was principally adopted by athletes and is represented on Greek statues and vases, the practice consisted in tying up the prepuce with a small band, either because the Greek were ashamed of a short foreskin associated with uncovering of the glans, or because they believed that physical strength could better be preserved in this way The phallus curvatus, which is often depicted on th vases and statues of antiquity, especially among the followers of Dionysus, the Sileni, and Satyrs, and was by no means uncommon among revellers and caricatures is regarded by the author as symbolic of a life of sexua excess, and therefore as having no possible connexio with infibulation. The work, which has obviousl involved an immense amount of literary and artisti research, is a valuable contribution to the sexuologica department of anthropology.

Dairy Engineering. By John T. Bowen. (Wiley Agricultural Engineering Series.) Pp. xiv+532. New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1925.) 18*s.* 6*d.* net.

THIS volume deals with the principles of engineering and their application to dairy practice. The method of presentation is clear and the subject matter well arranged, so that the book will serve as a useful and trustworthy guide to the dairy engineer, and also as a text-book to the student of dairying.

After a preliminary chapter on definitions, the subject of great importance in dairying—namely, the raising and application of steam—is dealt with. First the boiler and its fittings; then combustion and firing; then control of the air supply, which is an important factor in the economical use of fuel. The types of steam engine usually employed are described and their advantages and disadvantages discussed. As a proper arrangement for the carrying of steam to the different appliances is not infrequently overlooked in designing a factory, the chapter dealing with steam piping and accessories is of special interest. Attention is also directed to the advantage which is gained by the use of exhaust steam, as by its employment much can be done in dairy practice.

The chapters dealing with refrigeration and insulation are good, but no detailed consideration is given to uch operations as pasteurisation or cream separation. The internal combustion engine and various types of lectric motors are considered in detail so far as heir applicability to the dairy factory goes. The dvantages and disadvantages of electric power are also discussed. There is a chapter on temperature measurement and control.

dmiralty Handbook of Wireless Telegraphy, 1925. Prepared by Capt. W. G. H. Miles. Pp. viii+547. (London: H.M. Stationery Office, 1925.) 5*s.* net.

HE style of this book is lively and spirited and the nformation conveyed is clear and accurate. It is eant for the information and guidance of officers and en of H.M. fleet, and the editor is to be congratulated n making the subject so interesting. The modern heory of electricity is first described, and so the theory f thermionic tubes follows very convincingly later on. esonance is first described analytically and then lustrated by what happens in daily life. We are told “walk across a room carrying a cup of tea, and ote . . .” The “jar”—the Service unit of electro-atic capacity—which equals the 900th part of the icrofarad, is much in evidence and so also is the mic” (the microhenry). W/T and R/T seem to be e contractions used in the Navy for wireless tele-aphy and radio telephony respectively, and this book oves that they are very convenient.

There are one or two slips that might be altered with vantage. The lines of magnetic force round two rallel wires carrying equal currents flowing in op-site directions are circles and have not the oval ape shown in Fig. 18. The modified type of urier series, also, shown on p. 439, will certainly t represent any kind of wave form. But these are ry small matters. Considering its value it is a very eap book, and can be strongly recommended.

The Extra Pharmacopœia of Martindale and Westcott. Revised by Dr. W. Harrison Martindale and W. Wynn Westcott. Eighteenth edition. Vol. 2. Pp. xlii+728. (London: H. K. Lewis and Co., Ltd., 1925.) 20*s.* net.

WHEN “Martindale” was divided into two volumes on the issue of the fifteenth edition in 1912, the dividing line ran roughly between drugs used in the treatment of disease, which were dealt with in volume 1, and an account of recent therapeutical research which, with much bacteriological, analytical, and other information of value to medical men and pharmacists, composed volume 2. This arrangement, which has proved convenient in practice, is still maintained, and as this is the third edition published since the division took place, it is clear that in its new form the book has lost none of its popularity.

Only those familiar with the enormous output of work, of very varied quality, in therapeutics and the associated sciences, can have any idea of the trouble expended by the authors in selecting material for inclusion, and of the labour necessary for the presentation of the approved data in the highly condensed form with which users of this book have become familiar. These two features are as characteristic of this edition as of its numerous predecessors.

The senior author will have the cordial sympathy of all his readers in the loss of his collaborator, Dr. Wynn Westcott, who died at Durban on July 30, 1925, while this edition was in the press.

Grundlinien zur Entwicklungsmechanik der Pflanzengewebe. Von Dr. H. Pfeiffer. (Abhandlungen zur theoretischen Biologie, Heft 20.) Pp. vi+99. Berlin: Gebrüder Borntraeger, 1925.) 6 gold marks.

A GREAT deal of this small volume on a particular branch of “theoretical biology” will be too theoretical for the average biologist. It seems doubtful whether long Latin terminologies and chapters on such subjects as “Die erkenntnistheoretische Begründung der Entwicklungsmechanik pflanzlichen Gewebe” really advance the subject appreciably.

Later chapters, however, are of interest, especially where they treat of recent work in this field, which is such a complex one, and so different in many ways from the corresponding field in animals, that every attempt to summarise and sift critically the materials is bound to be of service. We hope that Dr. Pfeiffer will follow this up by a further volume on the achievements rather than on the theoretical bases of this branch of science.

Mesopotamia: the Babylonian and Assyrian Civilization. By Prof. L. Delaporte. (The History of Civilization Series.) Pp. xvi+371. Translated by V. Gordon Childe. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1925.) 16*s.* net.

THIS is a quite useful summary of present knowledge of the subject, including a short history of each region, and chapters on its institutions, religion, economic and social structure, and contributions to knowledge. There are a number of small line drawings of typical works of art. The translation is not very happy in places, and there are some odd mistakes.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Transmutation of Elements.

IN a letter to NATURE of January 2, 1926, Prof. Smits records the obtaining of evidence of the transmutation of lead into thallium and into mercury. One of our research students has been employed for some time in an attempt to detect the transmutation of lead into thallium, but up to the present the experimental difficulties have not been satisfactorily overcome, and we are not yet able to make a definite statement on the matter as a result of this work. The experiments so far attempted in this Laboratory, and those contemplated in future efforts, have been designed to facilitate the entry of an electron into the nucleus of a lead atom in the hope of effecting a transmutation into an isobare of another element (thallium), rather than to bring about a transmutation by the ejection of a proton or an α-particle from the nucleus of the lead atom.

We may perhaps be permitted to review the results of attempts at transmutation of elements which have been recently recorded in the light of these two alternative possibilities. In the case of the transmutation of mercury (atomic number 80) into gold (79) which has been announced by Miethe and Stammreich, and independently by Nagaoka, the change might conceivably be effected either by the entry of an electron into, or by the removal of a proton from, the nucleus of the mercury atom. The same alternatives present themselves in regard to the transformation of lead (82) into thallium (81).

Prof. Nagaoka, in attempting to bring about the transmutation of mercury into gold, designed his experiments with the view of facilitating powerful disturbance of the mercury nucleus which might lead to the ejection of a proton, because considerations of the satellites of the spectral lines of mercury had led him to the conclusion that in this element a proton is "slightly detached" from the central nucleus, and therefore possibly capable of removal. His experiments, which yielded a positive result, do not, however, enable us to distinguish conclusively between the two alternative methods of transmutation.

In Miethe and Stammreich's experiments the arrangement was entirely different, and the gold was obtained from mercury-vapour lamps using a heavy current, but requiring that the potential difference should exceed only 170 volts. In the account of these experiments given in NATURE of August 9, 1924, the possibility of the transmutation being due to the disruption of the mercury nucleus appears to be the only explanation considered; but, as Prof. Soddy has pointed out, an atomic disruption is not necessarily involved, and the alternative of attaching an electron to the mercury nucleus needs to be taken into account. Certainly the nature of the experiment does not preclude this possibility.

In essentials the experimental arrangement employed by Smits was similar to that of Miethe, for it consisted of a quartz lead-vapour lamp of special design run at voltages of less than 100 and with currents up to 100 amps. Smits records that initially the spectrum showed only one of the mercury lines, 2536, and that very weakly, but that after running the lamp for 10 hours the strongest mercury lines in the visible as well as the ultra-violet region of the spectrum had made their appearance, and that the most characteristic thallium line was also visible.

Now in the case of the transmutation of lead (82) into mercury (80), the change may occur either by the intermediate production of thallium by one of the processes already suggested, and the subsequent conversion of the thallium into mercury by a second similar process, or it can occur as a one-stage change by the ejection from the lead nucleus of either one doubly charged positive particle (presumably an α-particle) or two singly charged positive particles (presumably protons) simultaneously. If the process occurs by the intermediate production of thallium, one would expect to find evidence of a relatively large amount of thallium compared with the amount of mercury produced. Prof. Smits does not appear to have found such an effect, for he records stronger evidence of the production of mercury than of the production of thallium.

In the circumstances of Nagaoka's experiments, in which very intense electric fields were employed, it is conceivable that these fields brought about a disruption of the nucleus, and that, as a result, a portion of the nucleus was thrown off. In the cases both of Miethe's experiment and of Smits' experiment, if such a disruption occurs, it must be brought about by a different means. When atoms are bombarded by electrons, it is possible that in a few instances an electron penetrates within the *K* shell of extra-nuclear electrons, though it is certainly surprising that this is possible in the circumstances of these experiments. When such a penetration does occur, the electron will be attracted towards the nucleus and may possibly be absorbed by it. Even so, in some cases the absorption of an electron by the nucleus may render the latter unstable and disruption may occur with the ejection of a proton and an electron, either separately or together, in which cas the final chemical state of the disturbed atom will b the same as if the electron had been absorbed by th nucleus and a stable condition attained.

If we adopt Nagaoka's view that there are "slightl detached" portions of the nucleus, disruption b the approach of an electron is perhaps more easil imagined. Moreover, since lead consists of severa isotopes, it is not unreasonable to suppose that th close approach of an electron to the nuclei of differen lead isotopes would have different results. It possible that the production of thallium results from on isotope, and the production of mercury from anothe

It must be remembered that if the transmutatio of one element into another is brought about by th ejection of some part of the parent nucleus, somethin corresponding to the final state of the ejected portio must be present to the same extent as the elemen resulting from the changed condition of the main pa of the nucleus of the parent atom. In the cas considered, if the thallium and mercury are produce in this way, one might expect to find hydrogen (perhaps in the latter case, helium) present to corr sponding extents, and it is possible that these mig be detected by spectroscopic observations und appropriate conditions.

In the case of transmutation by absorption electrons into the parent nuclei, one would not expe to find these other elements. It therefore appea that the most hopeful method of obtaining eviden as to the exact nature of transmutations such those recently recorded is from attempts to dete the lighter products as well as the heavier produ of possible transmutations.

A. C. DAVIES.
FRANK HORTON.

Royal Holloway College,
Englefield Green, January 7.

Foreshadowing Elements of Atomic Numbers 75, 85, 87, and 93 by means of X-rays.

IN your columns of Current Topics and Events, Dec. 26, 1925, p. 943, I notice a critical abstract of a series of articles by Dr. Druce and myself, relative to the existence of elements of atomic numbers 75, 85, 87, and 93, which appeared in the *Chemical News*, Oct. 30, Nov. 6, 13, 20, and 27. A later communication in the issue of Dec. 11, 1925, should be included, as reference will be made to it below.

In justification of our work I must state that Film No. 3, which gave us the evidence of the presence of element 75 and meagre evidence of the presence of element 87, is completely ignored in the critical argument in question. Manganese sulphate was used in this case.

The line on which we have attempted to establish element 87 (Film No. 3) is one of wave-length 1·032, a fairly strong line considering the range of exposure; not $\lambda = 1{\cdot}040$, because this line seemed to represent some other element, and in one case it was wide enough to include several lines ($\lambda 1{\cdot}040$ was, however, mentioned in this connexion, and I tried to make something of it, as an attempt was made by Dr. Druce to isolate element 87 chemically from pyrolusite, but this substance has, as regards this element, so far proved to be disappointing). On p. 289 of the *Chemical News* we say: "On investigation we find that this line of wave-length 1·032 Å units fell exactly between the theoretical $L\alpha_1$ and $L\alpha_2$ lines of element of atomic number 87. We looked for the $L\beta$ line of this element, but failed to find it, as the bromine-silver absorption bands on the film fell in the region where the line should appear as a very faint one." In the same journal for Dec. 11, 1925, this obscured line was indicated as it was seen by one of Messrs. Adam Hilger's research staff when I was examining the film on one of their spectrum comparators.

Had mercury been present sufficient to give rise to an L radiation, the whole of this radiation would have been excited at the voltage used, and the comparatively strong Hg$L\beta_1$ line would have appeared on the film; whereas, only the lines corresponding to the $L\alpha_1$ and $L\beta_1$ radiations of 75 were present, in addition to those mentioned above of wave-lengths 1·032 and 0·837 (the latter as afterwards approximately determined by means of the spectrum comparator). The three lines were of sufficient strength to stand out well on the film, which was clear and free from fogging and other obscuring effects, except in respect of the Br-Ag absorption region.

Referring to p. 339 (Nov. 27 issue of the *Chemical News*), Film No. 1 was not perfect throughout and the exposure was more on the long wave-length side, but the 1·43 line was clearly revealed. Film No. 2 showed fairly strong lines $\lambda = 1{\cdot}43$ and $\lambda = 1{\cdot}233$, but the range of oscillation was limited to the region where these lines fell. Film No. 3, therefore, afforded a crucial test, for it covered the range below $\lambda = 0{\cdot}837$ to that beyond $\lambda = 1{\cdot}539$. When this film was taken, two other films were consecutively obtained with the same exposure (6 hours) and the same range of oscillation of the crystal and the same setting of the spectrograph. One showed only the copper lines, and it was a perfect film in every way. The other showed only the $K\alpha$ and $K\beta$ lines of both zinc and copper, for a substance containing zinc had been rubbed on the copper anticathode. Two of these sets of lines on their respective films were used to check the 75 $L\alpha_1$ line on one of them by noting the displacement of this line relative to that of the $K\alpha$ line of zinc, using for this purpose the spectrum comparator mentioned above. The copper lines were used for registration in the usual way. This test showed a slight displacement of the line towards the shorter wave-length side relative to that of zinc.

Furthermore, had mercury been the cause of one of our lines in the above tests, the Hg$L\beta_1$ line should have appeared on these three films and the Hg$L\alpha_1$ line as well on the films containing the zinc and copper lines only, but no sign of these lines could be detected. All three films were clear and the copper lines were quite strong, as were the zinc lines in the one case where a zinc compound was placed on the anticathode as stated above.

Films Nos. 4 and 5 were taken, when a sample prepared from pyrolusite was rubbed on the face of the anticathode. Lines $\lambda = 1{\cdot}086$ and $\lambda = 0{\cdot}895$ were obtained corresponding very closely with the $L\alpha_1$ and $L\beta_1$ lines of element 85, which we commented upon thus: "They are too ill-defined for us to establish their identification with this possible element." Pyrolusite samples have so far given a number of lines we could not identify. In two cases "93" appeared to be foreshadowed, but we dismissed this matter in the following terms. "The last element of all, of atomic number 93, was discussed in our first communication . . . the possibility of this element existing having stimulated our research from the start. There is some evidence of its existence, but to be critical, the line 0·693 comes near to the limit of the region explored by the setting (oscillation) of the rocksalt crystal of the spectrograph, and edge effects are possible here. At any rate this may account for some of the extreme 'lines' given at the foot of columns 12 and 13"—p. 340, *loc. cit.* It is true another likely pair of lines of wave-lengths 0·888 and 0·897 appeared on another film, but we still hold the same view that 93 is too imperfectly foreshadowed to be seriously considered. The calculated wave-length of the $L\alpha_1$ line of 93 I find to be 0·8877.

With regard to the brass of the apparatus giving rise to a zinc line, Messrs. A. Hilger, Ltd., say no such line ever appeared on their films except in the case of the tungsten target, which has a brass overlapping edge that holds the target in place.

Referring to the last remark in the note in NATURE, this, in my opinion, is uncalled for, since we have placed all the cards on the table, and then say in effect "that the research we have started on the missing elements in, or in connection with, Group VII, is promising and the work is being continued." All the quotations are from our own writings as listed at the opening.

In conclusion, I only regard 75 and 87 as identified by means of X-rays, and these, so far as published, from manganese sulphate, and not from pyrolusite. Pyrolusite gives lines difficult to identify, but with manganese sulphate all the proper lines were, in my opinion, identified.

As regards the confirmatory evidence from Dr. Druce's chemical side of this research I instigated, this might be mentioned, but I must leave the chemical side to my colleague.

F. H. LORING.

WE have carefully examined Mr. F. H. Loring's part in six contributions as published in the *Chemical News*, and also the above communication, all in respect of the X-ray side of the research, and we have pleasure in stating that Mr Loring has correctly transcribed our measurements, and the statements made as coming from us are correctly so described.

ADAM HILGER, LTD.
F. TWYMAN (Manager).

THE position taken up in the note to which Mr. Loring's letter refers was that the X-ray evidence was insufficient definitely to establish his claims. Experience with apparatus similar to that used by Mr. Loring shows that the difficulty is not one of obtaining foreign lines but of eliminating them. Unless special precautions are taken, prolonged exposures give lines due to various sources in addition to those corresponding to the radiations from the anticathode. Two of the most common sources are zinc and mercury. If the exposure and conditions are such as to permit of the detection of small quantities of any element in the anticathode, then the zinc line must appear from the passage of the X-rays through the brass slit of the spectrometer and probably also from the brass of the tube itself. If we accept Mr. Loring's view that the line 1·43 is not the zinc $K\alpha$ line, then the necessary conclusion is that he could not hope, under the conditions of his experiments, to detect small quantities of elements in the material under investigation. The photograph to which reference was made in the note was made for the purpose of that note and showed both zinc and mercury lines.

Mr. Loring states that a comparison of the line 1·43 with the zinc $K\alpha$ line obtained on another film showed a slight difference in position between the two. It is possible to suggest various explanations for such a shift based on purely geometrical considerations, but a critical discussion of the point is impossible until a detailed account of the experimental arrangements is published. A better test would be to obtain both lines on the same plate. If the amount of element No. 75 present is so great that the $L\alpha_1$ and $L\beta_1$ lines appear with exposures insufficient to bring up the zinc line, then it should be relatively easy to obtain also the γ_1 line, which lies well outside the bromine absorption band.

The results claimed by Mr. Loring are so important that the X-ray identification of the lines should be placed beyond doubt, and this cannot be said to be the case until a satisfactory explanation is given of all the lines found on the films, and not merely of a selection of them, as has been done up to the present.

THE WRITER OF THE NOTE.

Genes and Linkage Groups in Genetics.

I FIND it a little difficult to deal with Prof. MacBride's reply to my letter, in NATURE of December 26, since it seems to me not to take any account of the numerous facts bearing on the point which I raised. I feel that the only course is very briefly to enumerate the chief of these facts, and leave other biologists to judge if Prof. MacBride is right in his strictures, or in his views of linkage. I do this at the risk of becoming tedious, because it appears to me very unfortunate that, when delicate quantitative methods are at length introduced into a difficult biological field, they should be attacked on what I consider wholly insufficient grounds by prominent authorities such as Prof. MacBride.

As I see them, the facts are these: (1) There are numerous pairs of characters of organisms which "breed true" and which, when the strains showing them in pure form are crossed, reappear in the F_2 generation in the ratio 3 : 1. This has universally been taken to indicate material *somethings* in the germ-plasm connected with the appearance of the characters in question, and segregating in a clean-cut way into the F_1 gametes—in other words, *genetic units*. These doubtless are "disturbances of the chromosomes," but they are equally genetic units, and we may continue to use the non-committal term *factors* for them.

(2) When two such pairs of factors (call them A and *a*, B and *b* respectively) have been separately identified in a species, we can then test them together in one experiment. If so, it is without exception found that one of two things will happen:—

(2*a*) However the factors are introduced into the cross, the results in all later generations are the same. The F_2 gives the ratio $9AB : 3Ab : 3aB : 1ab$, the back-cross to the double recessive the ratio 1 : 1 . 1 : 1. This has been universally taken to imply *independent segregation* of the two factors.

Or (2*b*), the result is different according as to how the characters are introduced into the cross. Taking, for simplicity's sake, only the result of back-crossing F_1 to the double recessive, then (i.) if the cross was $AB \times ab$, we get $nAB : 1Ab : 1aB : nab$, where $n > 1$. (ii.) If the cross had been $Ab \times aB$, precisely the *reverse* result occurs, namely, $1AB : nAb : naB : 1ab$, *n* having the same value as before. This has been universally taken to indicate genetic linkage (some degree of absence of independence) between the two factors. (iii.) In Drosophila there is the further fact that the results under (i.) and (ii.) differ according to the sex of F_1. The female gives the formula stated above, but the male, without exception, gives *n* infinite—*i.e.* linkage is complete in the male. How these facts bear any relation to Prof. MacBride's definition of linkage, I fail to see. The same factors in the same proportions are present in F_1 in both (i.) and (ii.), and in male and female under (iii.); yet the proportions of the normal type and what Prof. MacBride regards as the doubly pathological type (with both mutant characters) are entirely different in accordance with the way in which the factors entered the cross, and with the sex of the individual tested. That this reversal of proportions can have anything to do with the weakening of developmental energy of which Prof. MacBride speaks as the basis of linkage, is to me unintelligible.

(3*a*) Finally, we can define as the "percentage cross-over value" (N.B., *pace* Prof. MacBride, as a purely genetic concept, with *no reference* to possible cytological interpretation) the expression $\frac{100}{n+1}$.

(3*b*) If by the methods of (2*b*) above, A or *a* has been found to be linked with B or *b* with cross-over value *p*, and with C or *c* with cross-over value *q*, then it can now be prophesied that on testing B or *b* with C or *c* (α) linkage will be found between them; and (β) if *p* and *q* are small, the cross-over value will be the algebraic sum of $p \pm q$.

This prophecy has been repeatedly verified; and no exceptions occur to the rule, provided naturally that conditions are kept constant, as in any physical or chemical experiment. It is on this last general result that the hypothesis of linear arrangement of the factors is based. I can only repeat that if Prof. MacBride can advance any alternative explanation of these facts (which he has not yet done), it will be of great interest.

With regard to points in Prof. MacBride's reply, he is not accurate in stating that Jennings started by assuming chromosome-breakage. Jennings assumed nothing but the facts provided directly by certain breeding experiments—namely, the proportions of certain visible characters appearing after certain crosses. The genetical fact that linkage is broken in a regular percentage of cases is entirely independent of any cytological hypothesis advanced in further explanation of it; and I repudiate the suggestion that to state this is to show confusion of thought. I have tried hard to grasp Prof. MacBride's own definition of linkage. He states that the basis of a linkage-group is "an impairment . . . [of] 'develop mental energy' "; in other words, if I understand him aright, a kind of constitutional disease. Further, each of its constituent "factors" is a "symptom" of this diseased state. Hence, I take it, *Drosophila melanogaster* is afflicted with 4 of these constitutional diseases, of varying severity, since some exhibit many more "symptoms" (factors) than others. *D. obscura*, on the contrary, suffers from 5 such "diseases," and *D. virilis* from 6. Whether the greater intensity of linkage in the males indicates a greater severity of affection, I do not gather. I repeat that this is the only meaning that I can extract from his words; if I am mistaken, I apologise. Prof. MacBride also states that a unit-factor is a *change*, which to me is unintelligible. He also indulges in some speculations about the origin of mutations. This, however, has nothing to do with the point I raised, namely, the distribution of segregating factors, by whatever means originated, among the gametes.

Neither are the beliefs of Dr. Bateson or of Prof. Johannsen at issue. "What the policeman said is not evidence" holds good for science as well as for law. The facts alone concern us, and I have tried to confine myself to such simple facts as with the aid of half-a-dozen stocks of Drosophila could be easily imparted by practical demonstration to a class of undergraduate students, and are regularly so demonstrated in numerous American universities.

J. S. HUXLEY.

King's College, London.

A Metastable *P* Term in the Manganese Arc Spectrum.

THREE years ago Wentzel (*Phys. Zeit.*, 24, 104, 1923) pointed out that a metastable state of the manganese atom was to be expected and as evidence of this directed attention to a fivefold *D'* term. So far as the author is aware, *P'* terms in this spectrum have never been identified although they also should be expected.

In a letter to NATURE by Mr. Beese and me (December 26, 1925, p. 936) attention was directed to the fact, noticed by me, that in many spectra the frequency of the first *pp'* group is near to the difference of frequency between the two lowest energy levels in the same system, both in the spectrum concerned and in the spectrum of the once more ionised atom.

Dr. R. V. Zumstein, National Research Fellow at the University of Michigan, has kindly pointed out to me a group of six lines in the manganese spectrum. During Dr. Zumstein's researches on absorption in the spectrum of manganese (to appear in the *Physical Review*) these lines were found to be reversed in a heavy manganese arc but not absorbed by heated manganese vapour. These lines, therefore, must arise from low-lying energy levels in the atom but not from the normal state. Three of the lines were tentatively designated by Catalán (*Phil. Trans.* 223 A, 127, 1922) as the fifth triplet of the sharp series in what is now known to be the octet system. However, the intensities of these three lines are not in the usual order and are much too great for this assignment. The reversal of these lines in the heavy arc, while the other triplets of the sharp series are not reversed, makes it certain that Catalán's assignment is incorrect.

The above-mentioned group of six lines satisfied the relation pointed out in the first paragraph for the location of the *pp'* group, and, on examination, these six lines are found to form a normal *pp'* group. The data are given in Table I. The principal narrow triplet is the first triplet in the sextet principal series. The first triplet in the septet system of ionised manganese is seen to be actually entwined with the *pp'* group. The *pp'* group is seen to be normal in structure. The behaviour of these lines in the arc and absorption as described above is in accord with their assignment as a *pp'* group. The Zeeman pattern has apparently never been determined for this group of lines. However, there seems little room for doubt that these lines are a *pp'* multiplet in the octet system of Mn I, involving a metastable threefold *P* term. Since the *pp'* frequency is so near ${}^7S_3 - {}^7P_4$, the limit of the ${}^8P'$ terms must correspond to an ionised manganese atom excited in a ${}^7P$ state.

TABLE I.

PP' GROUP IN MANGANESE I.

Principal Narrow Triplet, Mn I	ν =	35769·4 725·82 690·07
PP' Group	ν =	38512·7 554·5 683·4 686·4 815·6 857·1
Principal Triplet, Mn II .	ν =	38366·03 542·94 806·52

P_2		P_1		P_0	
		2592·95 (5) 38554·5			P_0'
		131·9			
2595·77 (4) 38512·7	*173·7*	2584·12 (3) 38686·4	*129·2*	2575·51 (5) 38815·6	P_1'
170·7		*170·7*			
2584·32 (4) 38683·4	*173·7*	2572·77 (5) 38857·1			P_2'

RALPH A. SAWYER.

Physical Laboratory,
University of Michigan,
Ann Arbor, December 5.

"Alchemistische Decknamen."

IN their recent paper under the above title (*Sitzungsber. d. Phys.-Med. Sozietät*, Erlangen, Bd. 56, pp. 17-36, 1924) Profs. Wiedemann and Ruska used (among others) the Dresden MS. 210, which contains a list of "Decknamen" for iron, copper, tin, lead, mercury and sal-ammoniac, twenty-four for each substance. It may be worth recording that a list so similar as to point to a common origin occurs in the British Museum MS. *Add.* 25724, ff. 15 *verso*-17 *recto*. This gives 24 names each for iron, copper, sulphur, tin, lead, mercury and sal-ammoniac, so that it affords a check upon Wiedemann and Ruska's list in the case of the six bodies mentioned, and supplements it with the names of sulphur, which are missing from the Dresden MS. The two MSS. agree in being anonymous, while the caption at the head of the list in the Dresden MS. is identical with that in the Brit. Mus MS.

i. *Iron.*—Names 1-5 and 7-24 are the same in both lists. The Dresden No. 6, *al adqār*, is replaced by *al-ashqar* ("the ruddy") in the Brit. Mus. MS. The latter reading appears to be preferable; I find no authority for Wiedemann and Ruska's translation of *adqār* as "Fuchsfarbige."

ii. *Copper.*—The two lists agree in all 24 names, except that the Brit. Mus. MS. reads *nāwūs* (sarcophagus) for *ṭāwūs* (peacock). It is difficult to say which is the more probable reading, though the characteristic colours of copper salts tend to favour *ṭāwūs*.

iii. *Tin.*—All the names are identical with the exception of Nos. 11 and 22. For the former, Wiedemann and Ruska read "*al qāṣirī*, das Mangelhafte." The Brit. Mus. MS. reads *al-qāḍī*, *i.e.* the judge, which is far more probable, especially as *qāṣirī* is apparently quite unknown to Arabic lexicographers For No. 22, Wiedemann and Ruska give "*al abīsmat al ḥağar* (unverstandlich; *basīmat al ḥağar* Lacheln des Steins [der Weisen] ?)." The Brit. Mus. MS. reads *ḥajar al-ishmīth*, *i.e.* the stone of *ithmid* or antimony sulphide (*kuḥl* or *στίμμι*).

iv. *Lead.*—The two lists agree in the main. Dresden No. 11, however, is given as *al sarzīn* (Wiedemann and Ruska:—"wohl verdorbenes persisches Wort"). The Brit. Mus MS. reads *al-razīn*, "the heavy, ponderous." Dresden No. 17 reads *al baḥs*; this appears to be a misprint for *al-naḥs*, since Wiedemann and Ruska translate the word correctly as *Schaden*. Dresden No. 18 reads *aḥraṣ*, rightly emended by Wiedemann and Ruska to *aḥras*, the Brit. Mus. reading.

v. *Mercury.*—Perfect agreement between the two lists.

vi. *Sal-ammoniac.*—Dresden No. 1, *al mukram*; Brit. Mus., *al-karam*. The former is preferable. Dresden No. 23 is "*al kajjis*, der intelligente"; the Brit. Mus. MS reads *al-layyin*, "the soft," which is clearly correct. Dresden No. 24 is the same as No. 22 ("*ṣābūn al ḥukamā'*, Seife der Gelehrten"), Brit. Mus No. 24 reads *shams al-ḥukamā'*, *i.e.* the sun of the sages.

vii. *Sulphur.*—Absent from the Dresden MS. The British Museum MS. reads as follows:—1. Quite definitely *al-laṭ'ī*, which is unintelligible. It may be a mistake for, or a modification of, *al-latha*, the gum or resin. 2. *al-wāqid*, the burning. 3. *al-'aqrab*, the scorpion. 4. *al-muḥriq*, the inflammable. 5. *al-nār*, the fire. 6. *al-aṣfar*, the yellow. 7. *al-sham'*, the wax. 8. *dhū al-janāḥīn*, the winged. 9. *al-ṣab'*, the indicator; but it is likely that a diacritical point has been omitted and that the true reading is *al-ṣabgh*, the dyer [*sc.*, of metals]. 10. *al-'arūs*, the bride. 11. *al-ṣamgha* (although there is no diacritical point over the *'ain*), the gum. 12. *al-khiḍāb*, the dye. 13. *al-zuḥār*, the moaner (possibly because of the crackling of a lump of sulphur when held in the hand). 14. *al-ṭalq*, the talc (mica, gypsum). 15. *al-dhahabī*, the golden. 16. *al-'alam*, the sign. 17. *al-bayraq*, the flag. 18. *al-jabal al-aṣfar*, the yellow mountain. 19. *al-ḥajar al-muṣaffaḥ*, the smooth stone. 20. *al-mubayyiḍ*, the whitener. 21. *al-musawwid*, the blackener. 22. *al-mulayyin*, the softener. 23. *zandarīkh*, sandarach. 24. *al-ḥimār*, the ass (or, since the first vowel is uncertain, the word may possibly mean "the redness." *Cf* Dozy, *Supplément, sub voce*).

E. J. HOLMYARD.

Clifton College, Bristol,
December 23, 1925.

Maori Rock-Carvings.

IN NATURE of November 21 last, p. 763, reference is made to an interesting discovery of Maori rock-carvings announced by the Wellington (N.Z.) correspondent of the *Times* in its issue of November 11. In that account there occurs the following passage. "Further exploration in this region [the Ngatihotu country] it is hoped may yield . . . possibly even a picture of a Moa which would establish the connexion of the Maoris or their predecessors with this great wingless bird. . . . Some authorities consider that the Moa was extinct before the first Maori migration, though it is admitted that the people who were here before the Maoris saw the bird in the flesh."

In the year 1889 it fell to me to explore the Sumner cave near Christchurch (N.Z.). The cave was concealed by a landslip (probably due to an earthquake) which had occurred before the colonisation of Canterbury Province. Its existence was quite unsuspected until the quarrying for road-mending of the stone supposed to be continuous with the live-rock of the hill of which it formed the fore-front, which had been going on for many years, suddenly broke into it On crawling in as soon as the orifice permitted, I found on the floor of the cave—a cavity fit to shelter a score of people perhaps—a fire-place with half-consumed wood projecting radially from it in an undisturbed position, just as left by the occupants who had hurriedly escaped, leaving their fire alight until it had burned out. They were evidently fisher-folk, for they left behind them fish hooks, net sinkers, paddles, numerous lengths of fishing-line of plaited human hair, and in their kitchen-midden broken shells, bones of seal, dog, Moa (partly burned, partly broken), and of other bird bones, among them those of an extinct species of swan (*Chenopis sumnerensis*) unknown to Maori tradition.

Evidence more important to the question being here considered, however, I found lying around the fire-place and in other parts of the cave, in the form of Moa egg-shells so disposed as to leave little doubt that their contents had been partaken of as a meal. Such portions of these shells as had not suffered by the fire still retained their internal membrane, indicating that the eggs when gathered were still fresh—or sufficiently so. Other objects obtained from the cave were a boat-bailer with quite characteristic Maori ornamentation, a carved curl-tailed dog (? head of a paddle), a tiki, one or two other greenstone objects, and a few obsidian flakes The cave-deposit consisted of sterile strata separated by well-marked hearths containing charcoal, shells, and fragments of bone, indicating an intermittent occupation of very long duration. The fall of material from the roof had been extremely slow since the closure of the cave, for the bailer, which lay on the surface hollow up, was practically empty. The occupants of the cave, as identified by their cultural objects, must be held to be of the same race as the present natives—unless the pre-Maoris practised a similar style of carving and of greenstone manufacture—and were obviously acquainted with the living Dinornis.

The contents of the cave were placed in the Canterbury Museum, Christchurch, of which I was then Director, and a hasty preliminary account appeared in the *Transactions of the New Zealand Institute* for 1890, less detailed, however, than the contemporary record, with photographs, preserved in my journal. My departure from New Zealand and multifarious imperious duties since have prevented the publication of the fuller details. I hope, however, with continued improvement in health, to make good my default shortly.

HENRY O. FORBES.

Luminous Leaves and Stalks from Bengal.

PROF. BULLER, of Manitoba, Winnipeg, in his "Researches on Fungi," vol. 3, published in 1924, states on p. 426 that he is now able to affirm that luminous leaves, in addition to occurring in France, Germany and Java, as reported by Tulasne in 1848 and Molisch in 1904, also occur in England, Canada, and the United States; and that as time goes on, doubtless many other countries will be added to this list.

In July last I obtained a collection of decaying leaves, small pieces of dead wood, living grass roots and stalks, living fern petioles, and living roots of

Averrhoa Carambola, giving out a distinct soft white light, from a covering of forest bed in Barisal in Bengal. Four years back I got a similar collection of luminous leaves, wood, etc., from the Bikrampur district in Bengal. In most cases I could find a colourless fungus-hyphæ in their sections. Luminosity was usually confined to certain spots only, while in some cases thin flat surfaces were luminous all over. Stalks showed a white streak of light along their lengths; no particular tissues within the stalks could be located as luminous.

Molisch attributed the cause of luminosity to fungi in decaying leaves, but so long as the fungus is not isolated and brought under pure culture so that its identity may be established, the point is not free from doubt. Molisch holds that the fungus gives out a photogen which, coming in contact with oxygen and water, gives out light; it is a process of slow chemical combustion without production of heat. But the photogen cannot be extracted. When I began crushing those luminous specimens with pestle in mortars containing a little cold and hot water in a dark room, the luminosity failed altogether, showing that photogen is not an extracellular secretion or excretion, but is bound up inseparably with the protoplasm of the living hyphæ—so long as the fungus is in a living condition it continues to emit light. The response of the light-giving substance in this case was in every way similar to that of a living one, namely, when I put those luminous specimens in a receiver and supplied them with a current of pure oxygen, they glowed more intensely than before. Light diminished on passing currents of pure hydrogen, nitrogen, and carbon dioxide gas, the former luminosity reappearing on access to the oxygen of the air. Putting specimens in a vacuum-bath and using an air-pump the light failed, but as soon as air was let in, the former condition of luminosity revived at once. Luminosity increased when specimens were immersed in dilute solution of hydrogen peroxide. Luminosity failed permanently on dipping the specimens in strong alcohol or chloroform, thus showing that if the fungus is somehow killed, there can no longer be the production of photogen.

The present lot of specimens remained luminous for about ten weeks, being kept in a moist condition. Specimens lose their luminosity when in a dried condition in blotting paper, but revive partially when in contact with water.

I could develop a photographic plate by exposing the film side to the direct action of a luminous stalk for nearly 48 hours, keeping a control.

S. R. BOSE.

Botanical Laboratory,
Carmichael Medical College,
Calcutta, November 26.

The Origin of the Satellites in the Ultraviolet OH Bands.

IN a letter in NATURE of February 7, 1925, p. 194, G. H. Dieke suggests that the numerous satellites in the ultraviolet OH bands originate in the same quantum states of the molecules as do the main lines. The test of this supposition is to see whether or not these faint lines are additional combinations between the same terms which are given for the principal lines, but sufficiently precise measurements for the application of this criterion have not been available. I have therefore remeasured the λ3064 band, using a high dispersion plate (1·3 Å.U. per mm.) on which this band was strongly developed, the main lines being necessarily over-exposed in order that the satellite system be well brought out.

The following "satellite" Q_1 and Q_2 series which, if combined with the main P and R lines, satisfy the combination relation $Q(m) - P(m+1) = R(m) - Q(m+1)$, have been located. They must, then, have the same final rotational state as the P and R branches, and so can be represented by the term formulas $F_1(m) - f_1(m)$ and $F_2(m) - f_2(m)$ respectively. Vacuum wave numbers are given, and unresolved doublets are denoted by *.

m.	$\sigma Q_1(m)$.	$\sigma Q_2(m)$.	m.	$\sigma Q_1(m)$.	$\sigma Q_2(m)$.
9	32283·74	32333·38*	18	31915·75	31944·36*
10	256·97	300·21	19	851·91*	885·41
11	226·49*	269·28	20	794·18*	820·96
12	192·24	231·48*	21	723·29	752·77*
13	154·69	192·24	22	653·88	683·42
14	113·27	149·53	23	577·50	604·27
15	070·55*	104·49	24		528·05
16	022·50*	053·50	25		439·38
17	1969·84				

It seems probable that most of the remaining satellites can also be represented by combinations between the terms in the main branches.

The same combination defect, $Q(m) - P(m+1) = R(m) - Q(m+1)$, which exists in these OH bands is also present in the magnesium hydride bands.[1] In view of the general similarity between the two band systems—both having the same characteristic spreading of the doublets near the band origins—it is reasonable to assume that the MgH bands, too, owe their combination defect to the existence of displaced Q levels. Satellite lines also exist in the MgH bands, but their investigation is obstructed by the presence of the many faint isotope lines.

These additional energy-levels have not as yet received interpretation in the theory of band spectra. More quantitative results such as the above would be a great aid in the solution of this problem.

The word satellite as used in this connexion, however, is somewhat of a misnomer, since, for example, $Q_2(24) - \sigma Q_2(24) = 2 \cdot 1$ Å.U., with five other lines falling in this interval.

WILLIAM W. WATSON.

Ryerson Physical Laboratory,
The University of Chicago,
December 22, 1925.

The Crystal as Diffraction Grating.

THE use of a crystal as a grating for measuring the wave-lengths of Rontgen rays affords a beautiful illustration of the value of a second reference frame that may be associated with the customary reference frame of vector analysis. Let $\mathbf{e}_1 \ \mathbf{e}_2 \ \mathbf{e}_3$ be the prime vectors of the customary frame. The second or derived frame, the prime vectors of which we will denote by $\mathbf{e}^1 \ \mathbf{e}^2 \ \mathbf{e}^3$ with superior affixes, is such that the scalar products $\mathbf{x}.\mathbf{e}_1 \ \mathbf{x}.\mathbf{e}_2 \ \mathbf{x}.\mathbf{e}_3$ of any vector $\mathbf{x}$ and the original prime vectors are the cartesian components of the vector in the derived frame, and the scalar products $\mathbf{x}.\mathbf{e}^1 \ \mathbf{x}.\mathbf{e}^2 \ \mathbf{x}.\mathbf{e}^3$ of the vector $\mathbf{x}$ and the derived prime vectors are the cartesian components of the vector in the original frame.

Because of this property we use $x^1 \ x^2 \ x^3$ with superior affixes to denote the components of $\mathbf{x}$ in the original frame, and $x_1 \ x_2 \ x_3$ for the components in the derived frame, so that with the usual convention as to the summation of affixes we write

$$\mathbf{x} = x^a \mathbf{e}_a = x_a \mathbf{e}^a$$

In a crystal of any form we take the origin at a point occupied by an atom, and for the heads of the prime vectors $\mathbf{e}_1$ $\mathbf{e}_2$ $\mathbf{e}_3$ we take three adjacent non-coplanar atoms. Let unit vector $\mathbf{r}$ give the direction of the incident ray and unit vector $\mathbf{s}$ that of the emergent ray. The conditions for the reinforcement of an emergent ray of wave-length λ are

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[1] W. W. Watson and P. Rudnick, *Astroph. Journal*, January 1926. That these bands have as their carrier the MgH+ ion is shown by several independent lines of evidence.

$$s_1 - r_1 = m_1\lambda \quad s_2 - r_2 = m_2\lambda \quad s_3 - r_3 = m_3\lambda \qquad (1)$$

where m_1 m_2 m_3 are integers.

We take a vector $\mathbf{m}$ the components of which in the derived reference frame are the integers m_1 m_2 m_3 so that

$$\mathbf{m} = m_1\mathbf{e}^1 + m_2\mathbf{e}^2 + m_3\mathbf{e}^3$$

Equations (1) are then all included in

$$\mathbf{s} - \mathbf{r} = \lambda\mathbf{m} \quad . \quad . \quad . \quad . \quad (2)$$

From this we have

$$\mathbf{s}.\mathbf{s} = (\mathbf{r} + \lambda\mathbf{m}).(\mathbf{r} + \lambda\mathbf{m})$$

or

$$2\mathbf{r}.\mathbf{m} + \lambda\mathbf{m}.\mathbf{m} = 0 \quad . \quad . \quad . \quad (3)$$

the equation that gives the wave-length.

The directions of the incident and emergent rays make the same angle with the vector $\mathbf{m}$ and this might be called the incident angle. The glancing angle θ, which it is the custom to measure, is the complement of the incident angle, and is the angle made with the mesh planes perpendicular to $\mathbf{m}$. It is given by

$$\cos 2\theta = \mathbf{r}.\mathbf{s}$$

which by the help of equations 2 and 3 becomes

$$\sin\theta = \frac{\lambda}{2} \text{ times the magnitude of vector } \mathbf{m}.$$

When m_1 m_2 m_3 are prime to one another, the distance d between successive mesh planes is the reciprocal of the magnitude of $\mathbf{m}$, so that

$$\sin\theta = \frac{\lambda}{2d}$$

The derived reference frame is equally appropriate in three dimensions and in four. D. B. MAIR.

January 11.

Weather Prediction from Observation of Cloudlets.

MR. CAVE writes: "I am not sure that I understand the second of Sir Archdall Reid's definitions of cloudlets—'small diaphanous clouds that can be seen at the same time in every part.'" The preceding definition was "the smallest and thinnest fragment of cloud that can be clearly isolated." I do not know how to express myself more plainly. On the other hand, Mr. Cave and I may not mean the same by "cumulus" and "cirro-cumulus." If there be any difference, then, since I am a mere amateur, I am sure he is right. I can only say that my suggestion as to the utility of observing cloudlets is founded on many years' experience, and, so far as I can judge, on common sense. To me it appears true (1) that rain is preceded by the condensing of clouds, and a return of fine weather by their dissolving; (2) that when clouds wax visibly rain is probable, and fine weather when they wane swiftly; (3) that, in proportion to their sizes and densities, the waxings or wanings of big clouds are difficult to observe; (4) that, in proportion to their smallness, thinness, and isolation, the behaviour of cloudlets is easy to observe; and (5) that the behaviour of cloudlets is usually an index of the behaviour of neighbouring clouds, and therefore of current atmospheric conditions. I find it hard to believe that clouds *commonly* change their behaviours so rapidly "that the method is scarcely of more use than the tossing of a coin."

It may be, as Mr. Cave says, that "Lenticular cirro-cumulus is composed of cloudlets that are born on the windward side and die on the leeward side of the cloud mass"; but, if so, the fact puzzles me. I can understand why a cloud should condense on the windward side of a cold mountain peak and dissolve to the leeward I can understand that a cloud may grow on its cold shadowed side while dissolving on its sunlit slopes—though, because of the difficulties of observation, I have never seen this phenomenon. But I cannot understand how wind can so affect cirro-cumuli that they grow to windward and dissolve to leeward. Are not these cloudlets *in* the wind (and therefore, in a sense, *out of it*) like plums in a pudding? This phenomenon also I have not seen: or at least have not connected with the wind. However, this is not a matter for the "likes of me" to theorise about. The fact remains that any one, at any time, on any day, when cloudlets can be isolated, may test, in a few seconds, the utility of weather prediction by means of cloudlets. I think, like Dr. J. W. S. Lockyer, he will find it useful. I wonder whether Dr. Lockyer can remember whether the rapid growth of his cloudlets usually presaged rain, and their dissolution fine weather? May I insist once more that I have only sought to indicate what seems to me an easily observed and exceptionally reliable weather sign?

G. ARCHDALL REID.

January 12.

Rate of Growth of Fungus Rings.

MR. O. G. S. CRAWFORD'S letter in NATURE of December 26, page 938, concerning the age of fairy rings, seems to warrant a letter for publication in addition to a more detailed private letter.

Fairy rings have been objects of interest from very early times and are the subjects of myths in most civilised countries, and are not beneath the notice of writers from Shakespeare to Kipling. As diverse as the myths are the suggestions regarding their mode of formation, ranging from fairy feet to fiery dragons and from thunder to moles.

It is now common knowledge that the rings are the result of a perennating fungus-mycelium and not of an annual spore discharge and germination. It is sometimes alleged that rings may remain stationary for several years; W. G. Smith stated that he knew a fairy ring of *Clitocybe geotropa* on Dunstable Downs which had remained much the same size for forty or more years. Most observers, however, agree that normally the rings increase in size. The rate at which the mycelium extends outwards varies considerably and is apparently dependent on weather conditions. There have been few actual measurements. Thomas studying rings of *Hydnum suaveolens* over a period of nine years found an average annual increase of 23 cm. Ballion records an increase of 12 cm. in one year for *Marasmius oreades*, but the advance was irregular being apparently more rapid when the ring was young, whereas for *Psalliota arvensis* the average increase was more than 50 cm. Bayliss with *Marasmius oreades* found the minimum annual increase to be 3 inches, the maximum 13½ inches. Shantz and Piemeisel estimated the average yearly advance as 12 cm. for *Agaricus tabularis*, and calculated certain Californian rings to be about 250 years old, and a number of small fragmentary rings which apparently had a common origin as approximately 600 years: the largest ring of *Calvatia cyathiformis*, with an average annual increase of 24 cm., was more than 400 years old.

It is obvious that the rate of advance depends upon the species of fungus concerned, and also upon conditions of environment which necessitates observations over a number of years.

It may be remarked that Prof. Buckman mentioned rings on Salisbury Plain more than fifty feet in diameter.

J. RAMSBOTTOM.

British Museum (Natural History),
London, S.W.7, January 7.

On the Structure of the D_3 Line of Helium.

DUE to the position of helium in the periodic table, relative to that of the alkaline earth metals, it has been frequently pointed out that its spectrum should consist of systems of singlets and triplets instead of the observed singlets and doublets. An unsuccessful attempt has been made to resolve the strong component of the doublet into the two expected components with the expected separation of approximately 0·17 Å.U., since the separation of the observed components is 0·34 Å.U. approximately.

A helium discharge tube wrapped in cotton which was kept wet with liquid air was used as a source, and the light was resolved by means of a quartz Lummer Gehrke plate and a small quartz spectrograph. Fortunately, the dimensions of the plate were such that one order fringe of the main component almost coincided with the next order fringe of the observed component. These together produced a single fringe of width about 1/5 the total distance between the fringes. The component looked for under these conditions should occur half-way between fringes.

Careful examination of the fringe system by both of us failed to reveal any trace of the expected component, though it would have been observed had ts intensity been equal to or greater than 1/40 that of the main component of this line and its separation rom the main component greater than 0·08 Å.U. Thus it appears that the structure of the $(1\pi - m\delta)$ series of helium does not correspond to the equivalent eries of the alkaline earth metals, calcium, etc.

W. A. MACNAIR.
W. H. MCCURDY.

Johns Hopkins University,
Baltimore, Md.,
December 20, 1925.

A Possible Origin of Petrol-Fields.

IT has frequently been suggested that natural mineral oils may be the product of decomposed fish. One of the main objections to this explanation has lways seemed the difficulty of accounting for the oncentration of oil deposits within the comparatively restricted areas in which they actually occur. But if one considers the migration of certain fish, for example he common eel, this objection can, in the main, be vercome.

It has now been definitely established that all the European eels make their way to a certain deep-sea rea in mid-Atlantic, where they spawn. The mature eels do not seem to return after spawning, only their ffspring appearing in the rivers in due course in vast numbers. If, as is probable, they die after reproduction, there must be enormous deposits under their pawning grounds, which might eventually be in part onverted into oil.

The quantities involved in this hypothesis appear o be in no way unreasonable. If one allows a eriod of say 10^7 years for the formation of the nited States oil-fields, which are estimated to have ontained two to three thousand million tons of oil, nd if one assumes that one eel on an average would rovide 100 gm. of oil, then to account for these eposits one would have to postulate an annual migration to the spawning ground of only 2 to 3 million eels. Thus even if the time and the yield have been overestimated by a factor of 10, there would still be a comfortable margin.

A. F. LINDEMANN.

Sidholme, Sidmouth,
January 12.

Measurement of Radiation Intensities by Photographic Methods.

REFERRING to Dr. F. C. Toy's letter, under the above heading, in NATURE of January 16, p. 83, Dr. John S. Anderson and I came to the same conclusion in an investigation published in the *Proc. Roy. Soc. Edin.* fourteen years ago. In the words of this paper, "Only when two beams of light of the same wave-length fall on adjacent parts of the same photographic plate and produce equal blackening in the same time can we say that their intensity is equal." This principle was made the basis of all the work we did at that time on ultra-violet spectrophotometry. But there are some fields, such as astrophysics, where it cannot be applied.

The object of this letter is to direct attention to the simple method we used for cutting down the intensity of the stronger beam. Half the slit of the collimator was illuminated by the light of an iron arc, and in the line between the slit and the arc travelled a ground quartz diffusing screen. The rays from the quartz screen filled the whole object-glass of the collimator. The intensity of illumination of the half slit varied consequently as the intensity of illumination of the ground quartz, and the latter varied inversely as the square of its distance from the arc. I have since used intermittent sectors and "neutral" absorbing screens which Dr. F. C. Toy favours, but am still of the opinion that for reducing the strength of the beam the inverse square law is preferable.

R. A. HOUSTOUN.

Natural Philosophy Department,
University, Glasgow.

The Occurrence of Dwi-Manganese in Manganese Salts.

FROM our respective communications (NATURE, vol. 116, p. 782; *Chem. News*, vol. 131, p. 273, etc., 1925) it was apparent that, although working on different lines, we had detected the element of At. No. 75 in manganese salts. A sample brought by one of us to Prague has been examined in the laboratories of the Charles' University. The sample was obtained from a solution of "pure manganese sulphate" by removing as much manganese as possible with hydrogen sulphide. When examined polarographically and also spectroscopically, it showed a similar content of dwi-manganese, namely, one per cent. The chemical properties of this mixture agreed with those previously announced from this University. Since we have reached the same conclusion by independent chemical and electrochemical methods, we consider the association of dwi-manganese with manganese as proved, and thus regard the name dwi-manganese (D) as most appropriate for the element At. No. 75.

V. DOLEJŠEK.
GERALD DRUCE.
J. HEYROVSKÝ.

The Institute for Experimental Physics
and Institute for Physical Chemistry,
The Charles' University, Prague,
January 12.

The Advancement of Engineering in Relation to the Advancement of Science.[1]

By Prof. A. E. KENNELLY, Harvard University.

THE term engineering is employed with many different shades of meaning. Tredgold's famous definition of civil engineering, which appears in the charter of the Institution of Civil Engineers (London), dating from 1828, commences with the excellent phrase "—the art of directing the great sources of power in nature for the use and convenience of man—." In Tredgold's time there were only two recognised types of engineering—*i.e.* civil and military. At the present time, nearly forty different branches of engineering have been itemised in technical literature. For the purposes of this discussion the following broad definition is suggested to cover all types of non-military engineering: "the economic application of the sciences to construction, production or useful accomplishment, especially on a large scale."

From this point of view, engineering manifests itself as the activating principle in the industrial world. Engineering, in this sense, must not only be coeval in antiquity with civilisation; but the degree of engineering attainment in any age must also necessarily be an index or criterion of its civilisation, judged from the material aspect.

The present era, which is essentially an engineering age, may be said to date from the introduction of the steam engine, and in that sense is only about one hundred years old. The application of the science of heat, in relation to steam for generating power, rapidly changed the nature of production from the individual-worker system to the factory system, augmenting greatly the output of a day's work. This in turn brought new dense factory populations, and also brought the means of supporting them. The so-called industrial revolution, thus started, brought tremendous sociological changes in its wake. Rapid steam transportation accelerated commerce and developed markets. It enabled producers to find sales for their products over a continually enlarged area. A sense of economic emancipation dawned over mankind.

During the Middle Ages and the Renaissance the study of science was slowly advancing in the western world, mainly under the guidance of the universities. This study consecutively followed the growth of mathematics, and was seldom directed to engineering applications. The natural philosophers, chemists and mathematicians who lived in the early years of the nineteenth century, taught and worked in intellectual regions usually remote from applications to utility. The rapid growth of the steam engine for driving factory machines, in the early years of the engineering era, brought into existence the mechanical engineer, who received his training in the workshop and factory. The mechanical engineer was compelled to study the nature of heat engines and of combustion, the laws of mechanics, and the properties of machines. This scientific study was, at first, more or less empirical and unsystematic. In the early days of mechanical engineering the physicists and scientists were ordinarily so far removed in their experiences from machines and engineering that they saw no way of co-operating with the engineer; while the engineer was so completely engrossed with the practical details of his work that he could see no way of receiving help from theoretical science.

The last few decades have steadily drawn together these two types of men and schools of thought, by mutual modification. The constantly increasing scale of machinery and machine production has necessitated more concentrated scientific study of the principles involved. The engineering applications have demanded more scientific knowledge, and the scientists have become more interested in applications. Until about fifty years ago the initial training of a young engineer, after leaving school, was either by apprenticeship to an engineering workshop, or by being articled, as an assistant, to a practising engineer. It is now recognised that the best training is in an engineering school of a university or technical college, where special study i devoted to the fundamental arts and sciences, followe by technical or applied science in some particula branch.

It is not only in the particular fields of engineerin that this close dependence of application upon th sciences has become essential; but also in manufacturing and general production. It may be safel asserted that manufacture, on a large scale, is so closel associated with engineering processes as virtually t become engineering itself. In other words, in order t carry on manufacture economically, on a large scale the process is practically the same as engineering There is the same need for scientific study of th principles and basic materials involved, the same nee for careful and thorough design, with the view o eliminating waste in material, plant or labour, the sam need for experience and skill in the various stages of th work, and the same necessity for careful preliminar estimates of cost, as well as of checking the cost i successive stages.

Every labour-saving appliance in manufacture, an every scientific improvement introduced into its procedure, is a new evidence of the identity betwee modern manufacture and engineering. A manufacturing community, in modern times of competiti and development, is of necessity an engineerin community.

Prior to the amalgamation of science and industry our present engineering age, the advancement of scien was made mainly in places where science was studi and taught; *i.e.* in universities, or institutions scientific learning associated therewith. Since t amalgamation, however, an increasing share in t advancement of science has been carried on in enginee ing establishments; *i.e.* in industrial laboratories, factory laboratories, or in government and sta laboratories. In future, the advances of engineerin and of the sciences upon which engineering depend will be so bound up and interconnected that whatev gives one a step forward must also give a like impu to the other.

It would no longer be possible to maintain the hu populations of many large cities in the world without engineering; *i.e.* without the continued economic application of the sciences to the supply of the many products those cities require.

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[1] From the address of the retiring chairman delivered on December 30, 1925, before Section M (Engineering), at the Kansas City meeting of the American Association for the Advancement of Science.

Although the needs of utility have in recent years either suggested or demanded numerous scientific researches, it is manifest that many other researches in the sciences are and will doubtless continue to be made exclusively for the truth's sake, and independently of any specific utilitarian need. It is only necessary to consider any scientific subject in all its bearings, to realise that this must be so. The great science of mathematics, for example, must evidently be greater than the sum of all its applications; so that unless all scientific curiosity as to the nature of new mathematical relations shall disappear, many investigations must continue to be made into branches of the subject that appear to have no immediate applications. Moreover, many cases of scientific research which have been made without any suspicion of applicability have afterwards come to be applied to very practical use. It would seem that the only differences which necessarily separate a scientific research of the basic or non-applied type, from one of the applied type, lie in the aims and motives of the researcher. In other words, one and the same research, conducted in the same way, may be an applied-science research or a basic-science research, according only to the purpose in the mind of the person who carries on the work.

It is generally conceded that researches carried on for the advancement of science tend strongly to stimulate the imagination. The investigator is called upon, at every stage of experimental inquiry, to speculate upon all the possibilities that present themselves, and to set up a new test that may serve to demonstrate which are the actualities and which the unrealities. It is not so generally recognised, however, that the work of the designing engineer also makes special claim upon his maginative powers in the material realm. Any new project, such as a large bridge, building, railroad or power plant, calls for a careful estimate and design. t has to be completely visualised, part by part, in the mind of the designer, before construction commences. The designer has then, either alone or with the aid of assistants, to realise his plans in two-dimensional drawings. A large project may involve the preparation of many hundreds of drawings, in advance of assembling the materials. All of these drawings must nterlock and connect in technique and dimensions. Tracings and blueprints from these drawings are then provided for guiding the constructors in their various asks. The assemblage of design drawings embodies in most new undertakings a considerable amount of nvention, imagination and creative work, which the builders proceed to translate from small scales in two dimensions, to full-size three-dimensional reality. To the trained eye, a good construction blueprint reveals, under its network of lines, a wonderful image of eality.

In the engineering of building construction, provision made for the proper conservation of æsthetic grace, y the profession of architecture. On its artistic side, rchitecture seeks to foster and promote the art of beautiful building construction. This professional attitude towards art in the engineering of buildings guides public opinion in such a way that graceless and inharmonious buildings seldom escape popular censure. In other branches of engineering the æsthetic quality of the product does not at present find similar professional safeguard. Nevertheless, there is, for each type of engineering construction, a certain somewhat indefinite standard of artistic appearance below which the designers and builders are sure to encounter hostile criticism. In every country, new types of machines, which are experimental and have not yet established their right to survive, are usually revealed by their awkward appearance. Each country develops, as a general rule, its own type of æsthetic standards in appearance, and experts frequently detect, in this way, the nationality of machines and the relative artistic engineering excellence of the nations in which those machines were produced. It is here again that the advancement of science reacts upon advancement in engineering; because the harmony in Nature that scientific study discloses, tends to guide the minds of those who apply the great principles of Nature to the satisfaction of human needs.

Just as the advancement of engineering construction, as for example in telescopes, is constantly tending to the advancement of the sciences, or of astronomy in the case considered; so in return the advancement of science is constantly tending to the advancement of engineering processes. Thus, the precision of geodetic surveying has greatly increased during the last few decades, owing to progress in the sciences of astronomy, mathematics, physics, metallurgy, geology, and others. Moreover, the demands made upon engineering design and construction tend ever to become more exacting. For example, it has recently been stated that the great new Philadelphia-Camden bridge across the river Delaware is the first in which the supporting towers have had to be given extra strength to withstand the possible accidental impact of an aeroplane.

So close is the present interconnexion between science and engineering that the only salient distinction between them lies in their respective relations to economics. Questions of cost inevitably present themselves in the study of basic scientific problems, if only as limitations to equipment; but they are ever present in the study of engineering problems. Indeed, engineering problems call for special methods of accounting, and emphasise the importance of determining amortisation, depreciation, effective rates of interest and present values of plants. The stocktakings of large-scale businesses likewise tend to become both economic and engineering inquiries.

As the entire civilised world becomes more and more given over to engineering, if only in order to support its large populations, it becomes evident that the conversion of factories for producing utilities into agencies for developing destructive and poverty-making warlike implements, is ever easier. The power of science to create in the hands of those who help, becomes equally the power to destroy in the hands of those who fight. The world has only too recently seen how terribly destructive the powers of science and engineering can become in war among the industrialised nations. Modern war is engineering gone mad. This misuse is, of course, no fault of either science or engineering. If, however, in the reasonably probable advance of both, we are to avoid the utter destruction of civilisation by war, and the economic servitude of posterity in its wake, we must all unite in building an international organisation that shall not only tend to prevent the onset of war but shall also swiftly suppress its first outbreaks. In any such organisation, both science and engineering are sure to be powerful elements for effecting control. Under such control, once successfully established, the advancement of science and engineering should surely promote and maintain world peace. Even now all science and its applications are essentially international. No way has ever been found to make science operate exclusively for the benefit of one nation, or portion of the globe.

In the basic sciences, the units of measure employed are almost universally the simple units of the international metric system—the metre and the gram—with their derivatives. In engineering and applied science, the units employed have gradually likewise become metric in all parts of the world except in the English-speaking countries, where both the time-honoured but cumbersome English and American systems of units persist. Even in the English-speaking countries, however, a gradual transition may be perceived towards the ultimately inevitable international metric system. When the transition shall have become complete, the mutual advances in engineering and in science will be rendered more easy and rapid, through the use of the same language of units. This simplification will benefit science and engineering in all parts of the world.

The advances of science and of engineering have thus far always enriched mankind materially. Material production has been greatly hastened; so that the average possessions of men have been increased, or else larger populations have been supported to divide the increase. It is doubtful, however, whether increase of human happiness, beyond a relatively small modicum of possessions, is at all commensurate either with the growth of material wealth or with the growth of population. It seems that while science can largely increase general comfort and prosperity, it can, at present, ensure but little increase of happiness and contentment. Whether this must always and inevitably be so, is debatable, and depends to some extent on our definitions of science. In any case we must turn for help to moral and spiritual sources of happiness if we are to continue to become increasingly indebted for material wealth to the scientific revelations of the interpretable universe. At present it appears that advancement in the power to enjoy and give contentment is more difficult for us collectively to acquire than advancement in the power to secure material benefit through science and engineering. In the discovery and maintenance of these uplifting philosophies the calm and contemplative Orient has surpassed the tense and restless Occident.

It is generally admitted that the study, either of the sciences or their applications, tends to produce in the mind of the student a sense of humility and a respect for truth. Indeed, it is not strange that habits of seeking or applying scientific truths should engender habits of faithful thinking. In this respect there is encouragement in the belief that the tendency of the present engineering age is, on the whole, towards accuracy of reasoning and precision of thought. Scientific ideas may tend slowly to dominate over irrational and irregular thinking. A casual review of general literature over long periods of time seems to show that as science has advanced, irrational and superstitious ideas have dwindled. The concomitant danger, however, lies in the occasional ravages of erroneous pseudo-scientific doctrines. A plausible but false doctrine, that masquerades as a scientific proposition, may produce more harm in a scientifically disposed world than a flagrantly immoral popular belief of a clearly irrational character. The responsibility for making unguarded statements that are unsupported scientifically, thus rests increasingly upon all speakers and writers.

In the development of the applied sciences, a constantly increasing demand devolves upon the underlying basic sciences. In the prehistoric times of primitive engineering, only the simple rudiments of the underlying sciences may have been involved. In the ancient Egyptian and Roman days, engineering must have demanded a closer study of mathematics and physics for support. Since, however, the dawn of the present engineering age, much more knowledge and research have been demanded in a long list of the branches of basic science. Invention is always needed. But whereas in past times, inventors, if they had the requisite talents, did not need much scientific knowledge, at the present time the successful inventor has not only to be endowed with inventive ability, but he must also be well versed in basic science. It appears that in the future this demand for basic scientific knowledge, as a prerequisite to applied-science progress, will continually increase.

The leadership of the ancient world rested mainly upon physical force. The trend of the more recent past through the present, towards the future, is for world leadership among the nations to rest mainly upon science and its applications. Already the progress of engineering is hampered and thwarted in many directions by lack of advance in the basic sciences. It is to these that national attention should be directed for the progress of the knowledge that benefits first the nation in which it is made, and later all the other nations. If only in the interests of applied science, the advancement of basic science should be stimulated and fostered. Support for applied science is likely to be forthcoming from the industries themselves; but support for basic science is more difficult to secure.

The national importance of this is so great that the need should be made widely known. An effective way to stimulate advance in the sciences in the United States would be to secure permanent endowment for a suitable annual prize, to the most notable contribution each year, in each section of the American Association for the Advancement of Science. This official recognition of scientific achievement would stimulate and encourage researchers in all the sections. There is no reason to fear that such scientific progress might be practically valueless. Useless scientific knowledge is now a contradiction in terms. Moreover, aside from the question of immediate versus future application, the patient earnest study of truth, in those parts of the universe that are attainable to us mortals, constitutes the noblest quest with which we are yet acquainted.

The Production of Motor Spirit from Heavy Oils.

By Dr. A. E. DUNSTAN.

IT is obvious that the provision of adequate supplies of motor fuel is a fundamental necessity of modern civilisation. Thirty years ago the light fractions of petroleum were not only a by-product in the preparation of kerosene, but also a positive nuisance, and vast quantities were deliberately burnt. In the interim the demand for motor spirit has steadily increased, and to-day has reached the colossal figure of eleven thousand million gallons per annum, Great Britain consuming nearly four hundred and fifty million gallons in the year.

This demand is increasing at the rate of about 30 per cent. a year in Britain alone, whilst the rate of increase on the Continent when trade becomes prosperous will inevitably be steeper than that in England. Last year, of the total amount of petrol produced in the United States, the straight-run gasoline distilled from the crude amounted to 56 per cent., cracked gasoline 33 per cent., natural gas or casing-head gasoline 10 per cent., and benzene 1 per cent.

It is clear that "cracking," *i.e.* the conversion of heavy oil into lighter products, is playing a more and more important part in the provision of motor spirit. The first successful attempts to bring about the conversion of heavy oils into lighter products were achieved by Dewar and Redwood in 1889 (English Patent 10277), and the object of this operation was the conversion of gas oil into burning oil. It was many years later that the conversion of burning oil and gas oil into petrol became desirable and practicable.

Although Redwood's patent was taken out in 1889, the writer had the advantage of seeing some time ago in Edinburgh a lay-out of a shale oil refinery in which this operation was actually provided for so far back as 1865.

The actual origin of cracking in the United States is supposed to be due to the carelessness of a stillman who, having left a still running, returned some hours later and found that a lighter distillate was being produced, and this was traced to condensate dripping from the upper cooler part of the still on to the hot residue. Between this early discovery and present-day big-scale cracking lies a period of intensive development, and it was only the perseverance of Dr. Burton that led to a refinery procedure being established on a large scale. The Burton process is really indistinguishable from that put forward by Dewar and Redwood; in effect, Burton merely heated petroleum residues at a temperature of 700° F. under a pressure of 4-5 atmospheres, the pressure being maintained right up to the outlet of the condenser. The real difference lies in the fact that Burton had developed the same procedure, but to a different end—the production of gasoline.

The first Burton patent was taken out in 1912. For a long time the Burton process was regarded with some disfavour, because of the relatively high pressure maintained in the still and the somewhat serious risks incurred by heating large masses of oil under these conditions, and the attention of innumerable investigators was directed to the cracking of hydrocarbons under atmospheric pressure. In Great Britain, for example, about the years 1913 to 1916, two at least of such processes were in operation. They failed, however, because the serious drawback of low pressure operation is a high yield of gas with corresponding low yield of gasoline, and that of a nature which makes refining extremely difficult. As will be seen in the sequel, it is by no means certain that vapour-phase cracking at atmospheric temperature is entirely defunct, because the nature of the spirit produced does offer certain advantages as a fuel for modern high-compression engines.

During the War, quite a considerable amount of attention was paid to vapour-phase cracking from an entirely different point of view. It has long been known that at temperatures in the neighbourhood of 750° C., paraffinoid hydrocarbons may be cracked, yielding considerable percentages of aromatic hydrocarbons. In a large-scale experimental plant operated at Thameshaven in 1916, working with heavy Persian oil distillates, a spirit was produced which contained no less than 16 per cent. of toluene.

Between 1916 and the last few years, however, the attention of inventors has been almost entirely directed to cracking under pressure, because it has been found that the spirit produced in this way is not only higher in yield but is also accompanied by far less gas and coke.

One or two typical methods of procedure may be very briefly outlined. In essence, all these processes consist of two parts: A pipe-still through which the oil is passed with considerable velocity at high temperature and pressure into a reaction vessel, in which it is maintained under pressure for varying lengths of time.

In the Cross apparatus—which is one of the most popular types—the oil is raised in the pipe-still to a temperature of about 470° C. and then passes into a reactor, which consists of a horizontal steel cylinder 40 ft. long, 38 in. in diameter, with walls 3 in. thick. The reactor is not directly heated, but is heavily lagged, and the oil is held in this chamber long enough to establish equilibrium between the liquid and vapour phases. This period is about 15-20 minutes, and the oil falls in temperature 50° between the inlet and the outlet. The operating pressure may amount to 750 lb. to the square inch. Normally in this process the amount of coke produced is less than 1 per cent.

After the reaction is complete, the oil is discharged into a separator and thence the vapours pass to the dephlegmator, where the temperature is regulated to yield gasoline to the required specification. The gas that is produced is nearly sufficient to maintain the necessary temperature in the plant. A modern unit will process 2000 barrels of oil per day, and if the intermediate oils produced in the operation be recycled to the plant, it is claimed that the yield of gasoline from a gas oil fraction may reach 65 per cent.

The Carleton-Ellis developments have led to the adoption of a vertical reactor which may be in duplicate. Oil is fed through the pipe-still under a pressure of 350 lb. and passes into vertical steel vessels, in which again the time factor is allowed to have its effect. After the reactor comes the dephlegmator.

The Dubbs' system is particularly adapted to the cracking of residue oils, although of course it will function on distillates. The process is simple in that the oil, after leaving the pipe-still, passes into a large reactor under a much lower pressure than that used by the Cross system. In the standard plant the oil enters the reaction chamber at 450° C., and the vessel is 10 ft. in diameter and may reach 30 ft. in height, with a capacity for coke ranging from 30 tons upwards. From the reactor again the vapours are subjected to dephlegmation, and a heavy condensate can be passed along with the incoming crude oil to the pipe-still.

The question of temperature in liquid-phase cracking is decided by the particular oil under treatment and the amount of gasoline required, because there appears to be a definite relationship between the variables time, temperature, and yield. It is interesting to note that the percentage of spirit obtained, after the oil has reached a definite cracking temperature, appears to double, within limits, for an increase of 10° C.

There has been little advance in our knowledge of cracking from a chemical point of view during the past ten years, because problems connected with cracking processes have been more often of an engineering nature, and the most urgent question to the majority of operators is the possibility of elimination—or at any rate the diminution—of coke, so that the plant may run continuously without the necessity for frequent shut-downs for cleaning.

It is surprising how little progress has been made in the examination of the residues left after the cracked gasoline has been removed from the synthetic crude oil, and investigators would do well to bear in mind that herein lies reactive material of unknown constitution, knowledge of which would probably amply repay intensive research.

Recent development in the design of the high speed, high compression, and high efficiency light car engine has brought to notice the importance of suitable fuel. It is in this connexion that cracked spirit shows particular advantages over straight run gasoline, in that it withstands high compression and is less prone to detonation, and it is a fact that, at the moment, quite considerable quantities of this material are being marketed as "anti-knock" motor spirit. The vapour phase product, having been processed at considerably higher temperatures, is specially noteworthy from this point of view.

No account of the present position of oil-cracking to-day would be complete without some consideration of the Bergius process, about which such far-reaching claims have been made. From the early work of Bergius there emerged the formation of artificial coal from cellulose at temperatures of 350° C. and pressures of more than 100 atmospheres. This substance was capable of hydrogenation by being heated to 400° C. in the presence of hydrogen at very high pressures. From this observation naturally led the application of hydrogenation to coal itself.

An entirely new technique had to be developed in this research and its later development, and only the discovery of a new method of joint construction rendered possible the application of very high pressures to this problem.

A commercial plant has been set up at Rheinau, and consists of an autoclave 30 ft. long × 3 ft. in diameter, fitted with stirring device and capable of handling 50 tons of material a day, under a pressure which may reach nearly 300 atmospheres.

In the case of coal, the material is ground to pass a 400-mesh sieve and is mixed with oil to permit of its passage through pipes. The autoclave is heated very ingeniously by surrounding it with heated nitrogen under pressure. Bergius has claimed that any coal containing less than 84 per cent. of carbon on an ash-free basis can be successfully hydrogenated.

In this connexion a good deal of work has been carried out the last few years in Great Britain, more particularly in the University of Birmingham, which more or less substantiates claims advanced by Bergius, and a variety of coals, lignites, and so on have been liquefied; but it should be borne in mind that the liquid product, whatever it may be, is certainly not petroleum, seeing that it contains liquid compounds of oxygen, sulphur, and nitrogen; and at the moment of writing it can be safely stated that the process has not yet been placed on a commercial basis.

Obituary.

Prof. Edmund Knecht.

By the death of Prof. Edmund Knecht, associate-professor of technological chemistry in the College of Technology, University of Manchester, chemistry, as applied to dyeing and other branches of textile industry, has lost one of its chief exponents.

Henry Edmund Knecht was the third son of Gustave Knecht, B.Sc. (Lond.), a Swiss who became a naturalised Englishman and for many years had a large private school in Liverpool, where Dr. Knecht was born in 1861. His mother was English. On leaving school he matriculated at the University of Zürich, studying chemistry under Victor Mayer, to whom later he acted as assistant. He graduated Ph.D. at the Swiss Federal Polytechnic in 1882, and returned to England in 1883 on his appointment as Head of the Department of Chemistry and Dyeing of the then newly opened Bradford Technical College. In 1890 he entered upon the long period of service at the Manchester College of Technology which ended only with his death.

When the Society of Dyers and Colourists was formed in 1884, Dr. Knecht became the first editor of the journal of the Society, a position which he held continuously for forty-one years and was the source of great satisfaction to him. To commemorate the completion of the fortieth year of his editorship, an excellent portrait of Dr. Knecht was issued with the journal and a valuable presentation was made to him, towards which subscriptions were received from the United States, Canada, India, Japan, and most European countries—for he had friends and admirers the world over.

Dr. Knecht was an indefatigable and prolific worker, his published researches, which number more than one hundred, appearing in the *Journal of the Society of Dyers and Colourists*, the *Journal of the Chemical Society*, the *Berichte*, and elsewhere. They cover a wide range, dealing with the production and application of dyestuffs, the chemistry of textile fibres and textile processes, etc. He also developed an entirely new series of analytical processes based on the use of titanium salts. He was the author alone or in collaboration of several standard works on dyeing, printing, and allied industries, the best known being the "Manual of Dyeing" by Knecht, Rawson, and Loewenthal. He also contributed a number of articles to the last edition of the "Encyclopædia Britannica."

Dr. Knecht was in good health until July last, when he underwent a serious operation from which he made a good recovery. Going to Switzerland to recuperate, he remained there until November, but during the whole time kept in close touch with the investigations carried on by his assistants in Manchester. Arriving in England during one of the worst fogs experienced for years, he caught a chill which developed into bronchitis, and he succumbed quite suddenly to heart failure on December 8 last, at his home at Marple, Cheshire.

As a teacher Prof. Knecht acquired a great reputation, not mainly through formal lecturing but by personal contact and example in the laboratory. The letters received from past students in many parts of the world at the time of the presentation recently made to him indicate the abiding affection in which many of them held "the Doctor."

Dr. Knecht was never married, but is survived by three sisters. He had the gifts of humour and good comradeship, but to hide an excessive sensitiveness and shyness he had also a natural reticence which was penetrated only by his intimate friends. His publications are characterised by sound judgment and lucidity, and frequently by those flashes of vision which connote genius. To no other man does the Society of Dyers and Colourists so largely owe its present considerable reputation; and it may truly be said that no man in any country has done more to enrich our scientific knowledge of textile materials and processes.

WALTER M. GARDNER.

MR. R. B. NEWTON, I.S.O.

RICHARD BULLEN NEWTON, lately senior assistant in the Geological Department of the British Museum, was born in London on February 23, 1854. His father was Librarian and his uncle (Mr. E. T. Newton, F.R.S.) Palæontologist to the Geological Survey. He was educated at the Central London Foundation School, Cowper Street, entering there as one of the first scholars. At the age of thirteen years, Newton obtained work at the Geological Survey, and in 1873 became one of the assistant naturalists under Huxley. In 1880 he was transferred to the British Museum and was soon engaged in the removal of the geological collections from Bloomsbury, and the rearrangement in their new home at South Kensington. He became an expert conchologist and especially interested himself in the Tertiary Mollusca, issuing a systematic list of the Edwards Collection in 1891. Other contributions flowed from his pen, to the number of about a hundred; many of them, though professedly systematic reports on collections of fossils sent to the Museum from distant regions, constituted considerable additions to our geological knowledge of Africa, Asia, and the near East. Another branch of his work was the study of the Foraminifera as guides to geological horizons.

In 1914 Mr. Newton received the Wollaston Fund from the Geological Society of London. He was president of the Malacological (1910–12) and of the Conchological Society (1913–15). His wide knowledge of fossils and their literature and his familiarity with the national collection made his services of much value to the British Museum and to the Empire at large. Since his retirement from the service he had continued to work in his old room at the Museum, and was hard at work there until, only a few days since, he left to undergo the operation to the effects of which he succumbed on January 23, in his seventy-second year. His helpful presence will be greatly missed by all his colleagues.

F. A. B.

WE regret to announce the death of Dr. Karl Goldschmidt, chairman of the directors and for many years head of the executive of the firm of Th. Goldschmidt and Co., of Essen, who succumbed to an operation on January 5 at Stuttgart, at the age of sixty-eight. He and his brother, the late Prof. Hans Goldschmidt, were well known as the inventors of "thermit," and in a recent monograph entitled "Aluminothermie," Karl Goldschmidt has described fully the nature and importance of the thermit-reaction. The brothers inherited from their father a chemical manufacturing business, which they transferred from Berlin to Essen thirty-five years ago. Under the management of Karl Goldschmidt, the business developed enormously and in 1911 it became a public company.

WE regret to announce the following deaths:

Dr. Charles A. Doremus, formerly professor of chemistry and toxicology at the University of Buffalo, known for his work on foods and on the chemistry of sanitation, on December 2, aged seventy-four years.

Mr. C. M. Doughty, honorary fellow of Gonville and Caius College, Cambridge, traveller and poet, the author of "Travels in Arabia Deserta," on January 21, aged eighty-two years.

Dr. C. Iris Fox, senior assistant pathologist at the Royal Free Hospital, Gray's Inn Road, London, who died as the result of a poisoned finger sustained during a *post-mortem* examination, on January 21.

Prof. C. Golgi, emeritus professor in the University of Pavia, Nobel prizeman in medicine with Prof. Ramon y Cajal in 1906, and distinguished for his work on the histology of the nervous system, on January 21.

Prof. H. A. Gossard, chief of the Department of Entomology of the Ohio Agricultural Experiment Station and president of the American Association of Economic Entomologists, on December 18, aged fifty-seven years.

Dr. W. R. Lang, formerly professor of chemistry in the University of Toronto, known for his work on low-temperature phenomena and on the chemical industries of Canada, on November 20.

Prof. Edward S. Morse, formerly professor of comparative anatomy at Bowdoin College, and also of zoology at Tokyo, an authority on Mollusca and on Japanese ceramics, who was president in 1886 of the American Association for the Advancement of Science, aged eighty-seven years.

News and Views.

An interesting announcement was made by Lord Reading in his speech as Viceroy at the opening of the Indian Legislature on January 20. A Royal Commission is about to be appointed: "generally to examine and report on the present conditions of agricultural and rural economy in British India." There follow particular directions, of which one is glad to see that the first subject of investigation will be "the measures now being taken for the promotion of agricultural and veterinary research." From time to time we have had occasion to direct attention to the remarkable success—particularly in plant-breeding—that has followed the labours of research workers at Pusa and other centres in India. There can be little doubt that the economic results that have already been achieved will impress the Commission, and that, as a result, a further extension of the work will be recommended. We hope the Commission will pursue the matter to the conclusion which the experience of state-directed research in Great Britain suggests, namely, that the successful exploitation of scientific research rests, in the last analysis, on fostering the supply of scientific workers. Considering the subject of economic botany alone, it is a somewhat remarkable fact that—save in some degree in the University of London—no universities in Great Britain undertake the specialised training of botanists in the economic aspects of the science. For some years past there has been a strong demand from India and the Dominions for trained geneticists, mycologists, and entomologists. It is not suggested that it would be possible to train men in England in the specific applications of these subjects in foreign countries, but training in the principles of the economic application of such sciences as genetics might well be attempted. As a corollary to this proposition, the new Commission might perhaps consider the desirability of assisting the universities by means of scholarship grants, or otherwise, following the time-honoured precedent of recruitment for the Indian Civil Service.

Presumably the Secretary of State for the Colonies will soon proceed to the appointment of a Director of the Amani Institute in Tanganyika. On December 9 the announcement was made in the Kenya Legislative Council that following on the recommendation of the East Africa Parliamentary Commission, the Secretary of State for the Colonies was taking steps for the re-establishment of this Institute. Each of the East African territories was asked to make a contribution towards its maintenance, their total contributions amounting to 8000*l.* yearly. In addition, initial capital expenditure of 6000*l.* was to be incurred. The contribution of the Imperial Government had not then been determined but it was hoped a sum would be set aside from the 10,000,000*l.* development loan. This announcement was received with enthusiasm by the representative of the Kenya settlers, Lord Delamere, who stated that the Colony stood to gain advantages out of all proportion to the contribution of 1200*l.* for which it was asked to make provision. But as the *East African Standard* pertinently remarks, the selection of the staff will need to be made carefully. It is obvious that the Director should be an able administrator and one who can command the confidence and continued support of the Governors, the Directors of Agriculture, the settlers, and the leading traders—preferably one who has a knowledge of the varied elements of the population and its needs For upon his relations with the various administrative and executive elements in the territories and his knowledge of the conditions prevailing will the success of this experiment depend. Perhaps these qualities can be found in one who could bring also a specialist's experience to bear upon the scientific problems with which the Institute is to deal. But the other desiderata should be the determining factors in the choice of a Director who will secure for the Institute the confidence and support necessary for its success.

The two children's lectures under the Dr. Mann Trust at the Royal Society of Arts this year assumed a strikingly novel form in the hands of Prof. H. E. Armstrong. They were, in fact, not lectures at all in the conventional sense. Prof. Armstrong conceived the characteristically original plan of imparting a notion of scientific method and its application to some simple things of daily life by going back to Lewis Carroll and the immortal Alice, and the lectures were entitled "Alice in Wonderland at the Breakfast Table." The plan was that a team of children assuming the familiar characters and acting under the general direction and commentary of Prof. Armstrong as a sort of Sage, should work out an experimental elucidation of some questions centring round carbon. Beginning with sugar and an excursion into the realm of nutrition, the course ended with the chemistry of egg-shell substance. The experimental procedure was masked, so far as possible, by breakfast-table appliances and procedure on "Alice" lines, and excellent effects were obtained by the use of very simple properties.

It was evident that much thought and ingenuity had been bestowed by Prof. Armstrong upon the production, but there had been a singular spell of ill-luck, several important members of the caste having to fall out at a late stage owing to illness or quarantine. In these circumstances the presentation necessarily seemed somewhat unrehearsed. The experimental part was excellently conceived and executed. The Mad Hatter had fortunately maintained a clean bill of health and played his leading part quite admirably. He had upon him (perhaps unconsciously) the burden of being the grandson of the two men who, in their generation, did more than any of their contemporaries to make science-teachers consider their ways—Prof. Armstrong in the physical and the late Prof. Miall in the natural history sciences. Though the representation suffered from the troubles already referred to, and though the "book" and comments in some places seemed to be a little out of tune with the juvenile mind, the venture was of very remarkable originality and interest. It left some of the adult members of the audience with the feeling that if Prof. Armstrong were to take his troupe on a provincial tour, it might reappear in one of the little (chemical) theatres of London and even make a modest bid for favour at Christmas with "Peter Pan."

In his Friday evening discourse at the Royal Institution on January 22, Sir William Bragg dealt with "The Work of the Davy Faraday Research Laboratory." He said the Laboratory was founded in 1896 by the late Dr. Ludwig Mond, who provided building, equipment, furniture and an endowment for its upkeep. It was entrusted to the care of the managers of the Royal Institution. Its purpose was the development and extension of chemical and physical research by methods suggested in the deed of trust, or by any other means that appealed to those in charge of the Laboratory. It was to be open to workers of any nationality, the sole qualification being the ability to carry on research, and no fees or expenses for electricity, water or gas were to be charged. This was, indeed, a free and generous foundation. The laboratory is well adapted to team work, inasmuch as it provides room for some fifteen to twenty workers, who can conveniently exchange ideas and give mutual assistance. It is actually employed in this manner, and all its rooms are occupied. The main problem under attack is the application of the new X-ray methods to the study of organic substances, that is to say, such substances as are of main importance in living organisms, and such other substances as are of similar structure and composition. This covers a vast range of materials, fats, oils, paraffins, alcohols, dyes, explosives, and so on. The work done is in the main contained in the realm of pure science. The new methods of analysis by X-rays are continually showing promise of useful applications to many industrial problems, but it is desirable that such laboratories as the Davy Faraday and the university laboratories should not allow themselves to be drawn away too far from the problems of pure research. If the latter be neglected, industrial applications will in the end lose their vitality.

In the improvement of our roads and canals in pre-railway times none played a more important part than Thomas Telford, whose great bridge over the Menai Straits was one of the finest engineering feats of the time. The bridge was opened on January 30, 1826, by the passage of the London and Holyhead mail coach across it, and it has therefore been in use for just a century. Its central span is 580 feet, while the carriage way is carried at a height of 100 feet above the water way. Early iron suspension bridges were usually made of ordinary chains, but in the Menai Bridge, Telford formed his links of flat bar iron 1 inch thick, 3½ inches wide, and 10 feet long. There are sixteen chains in all and the total sectional area of the main chains is 260 square inches. The cost of the bridge was 120,000*l*. Telford was sixty-eight years of age when the bridge was opened, but he continued to practise his profession until almost the end of his life. He died at 4 Abington Street, Westminster, on September 2, 1834, and was buried in Westminster Abbey.

The official opening on Thursday last, January 21, by Lord Lloyd, of the Sennar Dam across the Blue Nile at Makwar in the Sudan, marks the completion of the first stage of a great enterprise by which, ultimately, something like 3,000,000 feddans (Egyptian acres) of hitherto barren land will be rendered cultivable. The full scheme contemplates the provision of two dams, the second being across the White Nile at Gebel Aulia, a short distance south of Khartum; this will be required to ensure the summer water needs of Egypt. The area immediately available for cultivation amounts to 300,000 feddans and lies in the valley of the Blue Nile below Wad el Haddad, to the west of Barakat, which is the headquarters of the Sudan Plantations Syndicate, where a cotton-ginning factory has been established. The Sennar Dam is 3025 metres in length, but only 1800 metres of this is dam, properly so called, the remainder being side walling on the banks. The height of the crest of the dam above the river bed is 26 metres, and the foundations go down some 10 to 12 metres. There are 80 sluices in the main structure, each 8·4 metres by 2 metres; and 14 sluices (each 5 metres by 3 metres) for the regulation of the irrigation canal. The quantity of masonry in the dam is 423,000 cu. metres. The reservoir has a capacity of 636 million cu. metres, or about one-quarter the capacity of the enlarged Aswan reservoir.

The Netherlands expedition to the Karakoram Range under the leadership of Mr. P. C. Visser made several important discoveries during the past year. From a preliminary account in the *Times* of January 18, it appears that from Hunza the expedition ascended the Hunza valley and then branched off into the Bara-Khun valley, which was found to drain a vast region of glaciers and peaks of more than 22,000 feet. Then the Khunjerab valley was ascended and a high but comparatively easy pass was discovered leading to the Ghujerab valley. From this valley, which proves to be occupied by the longest of the head streams of the Hunza, by a lofty pass the Shimshal valley was reached. At the head of this valley two great glaciers were discovered, the Khordopin, 32 miles long, and the Verijerab, almost as long. A third glacier, the Yazghil, which flows in from the south, was explored. Mr. Visser believes this heavily glaciated region to include the largest expanses of ice in the world outside polar regions. Other explorations included an ascent of the Batura glacier, which was found to be 37 miles long, and a northern branch of the Hispar glacier flowing from the southern side of the high peak of Malunguti. The expedition, in addition to mapping more than 2000 square miles, has made large scientific collections. A full account of the work is to be given shortly to the Royal Geographical Society.

An exhibit of models illustrative of flint flaking made by Mr. S. Hazzledine Warren will be held in the lecture room of the Royal Anthropological Institute at 52 Upper Bedford Place throughout the month of February, during the hours at which the Institute is open. Fellows and others who may be interested in the subject are cordially invited to visit this exhibition and examine the models. They number more than sixty, and are planned on similar lines to the models used in the study of comparative anatomy and other subjects. That is to say, they are painted in conventional colours to indicate the comparisons of homologous parts as developed under various human, mechanical, and natural processes of flaking. It is intended to make a limited number of duplicate sets of these models, as a first attempt towards a standard set for comparison. So far as good natural flakings are concerned, so few have yet been collected that, for the time being, museums generally do not, and cannot, possess adequate specimens. Although plaster casts are inferior to originals, it is hoped that they may prove better than none.

SIR GILBERT WALKER, the new president of the Royal Meteorological Society, succeeded Sir John Eliot as Director-General of Observatories, India, in 1904, and retired from that position after twenty years' service under the age rule. During his tenure of office as Director-General he attacked the complex problem that had puzzled all his predecessors, that of forecasting the monsoon rainfall, by the statistical method of using coefficients of correlation. His most noteworthy official contribution to meteorology is a memoir on "A Preliminary Study of World-Weather," in which he has collected together all the correlation coefficients, large or small, and has discussed the physical interpretation of his results. Sir Gilbert Walker was a senior wrangler and a fellow of Trinity College, Cambridge. He is now professor of meteorology at the Imperial College of Science and Technology, South Kensington, and has the distinction of being the only professor of meteorology in the British Isles.

LIEUT.-COL. E. GOLD, who was presented with the Symons Gold Medal of the Royal Meteorological Society at its annual meeting on January 20, is assistant director of the Meteorological Office, member of the Aeronautical Research Committee, and president of the Weather Telegraphy Commission of the International Meteorological Committee, 1919. He has carried out studies on the dynamics of the upper atmosphere, the thermal conditions of the stratosphere, etc., his researches in these subjects gaining him his fellowship of the Royal Society, and the prize, offered for competition to the whole world by the German Meteorological Society, for a discussion of the dynamics and meteorological statistics of the upper atmosphere. During the War he acted as organiser and chief of the British Meteorological Section of the Army in France, and was well known through the British Army areas as Meteor G.H.Q. This section was of enormous importance to the success of the Air Force and, more especially, the artillery.

SIR ERNEST RUTHERFORD received his education at the Nelson Boys' College and the Canterbury College, Christchurch, New Zealand, and on the occasion of his recent visit to Christchurch, he was presented with an illuminated address. It shows Sir Ernest Rutherford's school and college as they were when he attended them, the chemical laboratory in which he worked, and the house in which he was born. The wording of the address evidences the weight attached in Christchurch to scientific distinction, and the esteem in which Sir Ernest Rutherford is held in his native land. The decorations on the address are highly creditable to the artistic taste of the designer.

RAINFALL statistics over the British Isles for 1925 are given by the Meteorological Office, Air Ministry, in the monthly numbers of the *Meteorological Magazine*. The normal rainfall for the British Isles as a whole for the 35 years 1881 to 1915 is 41·41 inches, and the rainfall in 1925 for the several divisions of the British Isles is given as percentages of the normal. For the British Isles as a whole and in the divisions England and Wales, Scotland, and Ireland the rainfall was less than in 1924 and 1923. The mean for Great Britain and Ireland was 104 per cent. of the normal, the heaviest fall being 108 per cent. in England and Wales February had the greatest excess of rain over the normal in England and Wales with 189 per cent. and June the lowest with 6 per cent. of the normal. In Scotland, May had the greatest excess with 191 per cent. of the normal and June the lowest with 39 per cent. of the normal; in Ireland, May had the greatest excess over the normal with 194 per cent. and June the least with 23 per cent.; for the British Isles as a whole, May had the greatest excess with 185 per cent. of the normal and June the least with 18 per cent. of the normal. At Camden Square, London, the principal station of the British Rainfall Organisation, the rainfall for the year was 24·91 in., which is 0·44 in. more than the normal. The wettest month was July with 3·58 in. of rain, which is 150 per cent. of the normal, but relatively February had more abnormal rain, the measurement being 2·86 in., which is 171 per cent. of the normal. The driest month was June with 0·11 in., which is only 5 per cent. of the normal.

A NOTE on "Drought, its Prevention and Cure" is given in the *Meteorological Magazine* for December from an article on the Kalahari project by Prof. E. H. L. Schwarz. The author is well known for his proposals to increase the rainfall of South Africa by reconstituting the ancient lakes of the Kalahari region. Instances are cited of the extensive desiccation of large areas originally extensive lakes, and this is especially treated with reference to Africa. The author mentions that in Central Africa the great lakes still function as sources of rain for the interior, but he refers to imminent danger that Lake Victoria will be drained into Tanganyika, with disaster to the whole Nile Valley. Attention is directed to the water supply to the Kalahari lakes being intercepted through the Victoria Falls probably about 500 years ago. River piracy and geographical changes are possible and even probable; the part which concerns meteorology is the effect of such changes on rainfall. Reasoning on certain internal changes in South Africa, the author points to an average decrease of about one inch per annum in the rainfall between the periods 1881 to 1900 and 1901 to 1920. The author of the note refers to Bathurst having a decrease of nine inches per annum during the same period, and at Sierra Leone a decrease of 25 inches per annum. Even in the Cape Verde islands in the open ocean, the rainfall has suffered a marked decrease. These facts are taken to suggest that the disappearance of the Kalahari lakes is part of some more general change which human endeavour cannot hope to cope with. The article was the subject recently of an interesting discussion in the Meteorological Office.

THE recently published list of sectional presidents at the British Association meeting in Oxford next August has been completed by the appointment of Sir John Snell, chairman of the Electricity Commission, as president of Section G (Engineering).

AT a meeting of the Zoological Society of London held on January 20, it was stated that the total number of visitors to the Society's Gardens for last year was 1,823,618, a decrease of 233,528 as compared with the previous year. The number of visitors to the Society's aquarium during the period was 423,657.

HIS Majesty the King has consented to become patron of the annual general meeting of the Society of Chemical Industry to be held in London during the week commencing on July 19. The third Messel Memorial Lecture will be delivered by Lord Balfour at the Mansion House on the afternoon of the first day of the meeting.

A LIMITED number of bacteriological microscopes by Koristka are being offered for sale at a reduced price by Messrs. The City Sale and Exchange, Ltd., 81 Aldersgate Street, London, E.C.1. The microscope stand has a wide body tube fitted with draw tube, and is provided with a double rack-and-pinion coarse adjustment, a graduated fine adjustment, rotating stage, and a sub-stage with focussing adjustment. We have examined one of these instruments and consider it well made and capable of giving useful service in serious bacteriological or general microscope work. It is equipped with three objectives, $\frac{2}{3}$ in., $\frac{1}{6}$ in., and $\frac{1}{12}$ in. oil immersion, in triple revolving nose-piece, three eye-pieces, and an Abbe condenser with iris diaphragm. The price for the complete equipment in carrying case is 19 guineas, and the firm is prepared to supply the instrument on seven days' approval and also, if desired, to accept payment by instalments.

WITH reference to the note in NATURE of January 23 (p. 136), on the discovery of the capelin in glacial nodules in S.E. Bosnia, Mr. Errol I. White, of the Department of Geology, British Museum (Natural History), informs us that one of the specimens has been presented to the national collection by Dr. St. John Bolkey and is on exhibition at the Museum.

DR. R. B. MOORE, formerly chief chemist of the U.S. Bureau of Mines, who was largely responsible for the development of helium production during the War, has been awarded the Perkin Medal for 1925 by the American section of the Society for Chemical Industry. The presentation was made on January 15.

THE Rivers Memorial Medal for anthropological work in the field for 1925 has been awarded by the Council of the Royal Anthropological Institute to Prof. C. G. Seligman for work in New Guinea, Ceylon, and the Sudan. The Medal was presented to Prof. Seligman by Dr. A. C. Haddon at the anniversary meeting of the Institute on January 26.

IT is stated in the *Times* that in celebration of the centenary of the death of Stanislas Staszic, scientific worker, business man, and statesman, the Polish Government has restored to the Warsaw Scientific Society the palace presented to that body by Staszic, but afterwards confiscated by the Russians.

THE treatment of tuberculosis with sanocrysin, a thiosulphate of sodium and gold, introduced by Prof. Mollgaard of Copenhagen, has attracted attention, and Prof. T. R. Elliott details the results he has obtained with it in eleven cases (*Lancet*, January 16, p. 126). He thinks that, used with care, the drug does no harm, and his impression is that it produces more rapid improvement in pulmonary tuberculosis than could be obtained by any other method of treatment.

THE Council of the Geological Society has this year made the following awards:—Wollaston Medal to Dr. Henry Fairfield Osborn of the American Museum of Natural History; Murchison Medal to Dr. William S. Boulton, professor of geology in the University of Birmingham; Lyell Medal to Dr. O. T. Jones, professor of geology in the University of Manchester; Wollaston Fund to Mr. A. L. Leach; Murchison Fund to Mr. W. S. Bisat; Lyell Fund to Mr. F. Raw and Mr. A. F. Hallimond.

AN International Photographic Exhibition in Esthonia is being organised by the Esthonian Photographic Club in Tallinn (Reval) on May 2-16. Exhibits will be arranged in five sections: (1) Artistic photography, (2) photography in natural colours, (3) applications to science and industry, (4) photomechanical processes, (5) literature. Applications to exhibit must reach the Club by March 15 and exhibits by April 15. An illustrated handbook of the Exhibition containing also articles of professional interest is to be issued.

AT the annual general meeting of the Royal Meteorological Society, held on January 20, the following officers and new members of council were elected: *President*, Sir Gilbert Walker; *Vice-Presidents*, Capt. C. J. P. Cave, Col. H. G. Lyons, Dr. G. C. Simpson, Mr. G. Thomson; *Treasurer*, Mr. Francis Druce; *Secretaries*, Mr. R. Corless, Commdr. L. G. Garbett, Major A. J. H. Maclean; *Foreign Secretary*, Mr. R. G. K. Lempfert; *New Councillors*, Mr. R. Arnison, Miss E. Elaine Austin, Dr. H. Jeffreys, Mr. I. D. Margary, Lt.-Commdr. E. C. Shankland.

A meeting of the Society, which will take the form of a conversazione, will be held in the new galleries of the Science Museum, Exhibition Road, South Kensington, by invitation of Colonel H. G. Lyons, Director of the Museum, on Wednesday, February 3, at 5 P.M., to see the meteorological and physical collection. A gallery which has just been opened contains a large and effective display of meteorological instruments and weather charts, both modern and historical.

A CONVERSAZIONE will be held by the British Science Guild in the Carpenters' Hall, Throgmorton Avenue, E.C., by kind permission of the Master and Court of the Carpenters' Company, on Thursday, February 11, 4.30–6.30 P.M. Brief addresses will be given on the scientific approach in administrative problems, on the use and abuse of the "conference" instrument, on losses from avoidable fires, and on losses from timber disease. Admission will be by card of invitation only, to be obtained on application to the Secretary, British Science Guild, 6 John Street, Adelphi, W.C. 2.

AT the annual meeting of the Royal Microscopical Society held on Wednesday, January 20, the following officers and new members of council were elected: *President*, Dr. James A. Murray; *Vice-Presidents*, Mr. A. Chaston Chapman, Mr. M. T. Denne, Dr. R. J. Ludford, Sir Charles Parsons; *Treasurer*, Mr. Cyril F. Hill; *Secretaries*, Mr. Joseph E. Barnard, Dr. Clarence Tierney; *New Members of Council*, Dr. R. S. Clay, Dr. A. S. Parkes, Dr. A. Piney, Mr. E. A. Robins; *Librarian*, Mr. Robert Paulson; *Editor*, Dr. J. W. H. Eyre; *Curator of Instruments*, Mr. W. E. Watson Baker; *Curator of Slides*, Mr. E. J. Sheppard.

THE Council of the Institution of Electrical Engineers has made the fifth award of the Faraday Medal to Colonel R. E. B. Crompton, honorary member of the Institution. Colonel Crompton, who has twice been president of the Institution, is one of the early pioneers of electrical engineering and has played an outstanding part in the development of electricity supply in Great Britain. The Faraday Medal is awarded not more frequently than once a year either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science without restriction as regards nationality, country of residence, or membership of the Institution.

THE New York correspondent of the *Times* announces that the Universal Oil Products Company has given a sum of 50,000*l.* to the American Petroleum Institute. This is in addition to the gift of 50,000*l.* made last December by Mr. Rockefeller, jun., for the encouragement of scientific research in petroleum. The Institute also announces that Mr. Charles E. Hughes has been retained to represent it before the Federal Oil Conservation Board.

WE are informed that Messrs. R. and J. Beck, Ltd., are opening new premises situated at 69 Mortimer Street, London, W.1. More accommodation will thus be provided for demonstration purposes in conjunction with microscopes and optical instruments.

WE have received from Messrs. Everett, Edgcumbe and Co., Ltd., an account of their exhibits at the Physical and Optical Societies' recent exhibition of apparatus, amongst which may be mentioned an integrating photometer for measuring by a single observation the mean-spherical candle-power of a lamp. The lamp under test is placed at the centre of a 3-ft. cubical enclosure with white interior walls, and a sample of the general illumination inside the enclosure is compared, in a photometer shielded from direct illumination, with that of an external lamp the distance of which from the photometer has been previously adjusted by comparison with a standard lamp at the centre of the enclosure. Another interesting feature was a 1000-amp. transformer for use up to the higher wireless frequencies. In this apparatus the secondary circuit and the magnetic circuit are enclosed within the primary current sheet, the primary circuit consisting of an entire copper sheath, which also serves as an electric shield.

MESSRS. Dulau and Co., Ltd., 34 Margaret Street, W.1, have just circulated Catalogue No. 136 of nearly 1200 works dealing with zoology, geology, and palæontology. Copies of the catalogue can be obtained free upon application.

MESSRS. W. Heffer and Sons, Ltd., Cambridge, announce the early publication of a new edition, the seventh, of S. W. Cole's "Practical Physiological Chemistry," containing two additional chapters on, respectively, biological oxidations and reductions, and the analysis of blood.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A principal of the Chesterfield Technical School—The Director of Education, St. Mary's Gate, Derby (February 8). A lecturer in the department of Civil Engineering and Surveying at the Imperial College of Science and Technology, City and Guilds (Engineering) College—The Secretary to the Delegacy, City and Guilds (Engineering) College, Exhibition Road, S.W.7 (February 15). Sir Ernest Cassel readerships at the London School of Economics in economic geography and in foreign trade—The Academic Registrar, University of London, South Kensington, S.W.7 (February 18, *not* March 9 as previously announced). A scientific assistant at the Royal Aircraft Establishment, primarily for research in connexion with electrical ignition appliances—The Superintendent, R.A.E., South Farnborough, Hants (February 20) (quoting A.81). A curator of Museums under the Libraries, Museums and Arts Committee of the City of Liverpool—The Town Clerk, Dale Street, Liverpool (February 27) (endorsed "Curator of Museums"). A professor of metallurgy in the University of Birmingham—The Secretary, University, Birmingham (March 1). A professor of physics at University College of North Wales—The Registrar, University College of North Wales, Bangor (March 20).

Our Astronomical Column.

NEW COMET.—Another new comet, 1926*b*, was discovered at Braamfontein on January 16, by Mr. T. E. Blathwayt, who immediately communicated the news to the Union Observatory at Johannesburg, where an observation was secured a few hours later. The comet was then in Declination 30° South, but it was moving rapidly northward, and will be observable in England when the moon approaches new. Observations by Mr. Jeffers at the Lick Observatory, and M. Renaux at Algiers, have come to hand. From these Dr. A. C. D. Crommelin has computed the following orbit:

$$\begin{array}{l} T\ 1926\ \text{Jan.}\ 3{\cdot}3481\ \text{U.T.} \\ \left.\begin{array}{llll} \omega & 328^\circ & 41' & 57''{\cdot}6 \\ \Omega & 136 & 3 & 58{\cdot}2 \\ i & 128 & 22 & 2{\cdot}8 \end{array}\right\} 1926{\cdot}0 \\ \log q\ 0{\cdot}129327 \end{array}$$

EPHEMERIS FOR 0^h.

	R.A.	Decl.	log r.	log Δ.
Jan. 27	$11^h\ 8^m\ 26^s$	17° 51′ S.	0·1435	9·7418
,, 31	10 31 5	8 54 S.	0·1484	9·6877
Feb. 4	9 46 27	2 33 N.	0·1539	9·6562
,, 8	8 58 19	14 36	0·1600	9·6635
,, 12	8 11 15	24 47 N.	0·1666	9·7062

The magnitude was 11 at discovery; the approach to the earth will probably cause a slight brightening.

PROF. W. H. PICKERING'S WORK ON MARS.—The Draper 11-inch refractor with which Prof. Pickering has observed six apparitions of Mars since 1912 at Mandeville, Jamaica, has now been recalled to Harvard. Though he hopes to observe the next apparition there with another telescope, he thinks it is a good occasion to summarise his results. A paper in *Popular Astronomy* for November 1925 contains his measures of the polar caps. As has previously been noted, the circumpolar regions are veiled with clouds when the cap is forming, which takes place fairly rapidly. Then the clouds disperse, leaving the dazzling snow surface visible.

Owing to the eccentricity of the orbit the southern cap is larger than the northern, but melts more quickly. A great fraction of the total moisture of the planet, which Prof. Pickering estimates as about equal to that in the great American lakes, is concluded to oscillate between the two polar regions, fertilising each hemisphere when it melts.

Prof. Pickering alludes to the results obtained by Drs. Adams and St. John with the Mt. Wilson 60-inch mirror (*Pub. Ast. Soc. Pac.*, 1925, 37, 158). They find that the water vapour in Mars' atmosphere is of the order of 5 per cent. of that in our own, and the free oxygen 15 per cent. of that in our own. These facts, combined with the thermopile results indicating a fairly high day temperature, suggest that the conditions for habitability are more favourable than were supposed some years ago.

RECENT SUNSPOTS.—The two large groups of sunspots which were seen during the latter half of December have returned as naked-eye objects. The preceding spot, south of the sun's equator, represented the following of the two spots originally composing the group. The great spot in the northern hemisphere has returned increased in extent, and on January 19 and 20, although much foreshortened near the sun's limb, it was easily seen with the naked eye. This single spot is one of the three largest which have appeared within the last fifty years. Its area on these two days exceeded 3000 millionths of the sun's hemisphere; its length, 8½ degrees of solar longitude, is equivalent to about 60,000 miles.

There have been other spots of minor importance. The large stream of spots, seen on the central meridian on December 16, has returned though much diminished, and the leading spot of an earlier stream (central meridian passage, November 24) has been seen for the third time.

The following table continues the information of naked-eye spots:

No.	Date on Disc, 1926.	Central Meridian Passage.	Latitude.	Maximum Area.
1	Jan. 16–29	Jan. 22·3	21° S.	1/1000
2	Jan. 18–31	Jan. 24·6	22° N.	1/300

(Areas express the proportion covered of the sun's hemisphere.)

AUTOMATIC REGISTRATION OF STAR-TRANSITS.—The problem of making the stars automatically record the time of their transit over the wires of a transit circle is an attractive one, to which many astronomers have devoted some thought since the introduction of photography as an aid to stellar observation. Mr. Bengt Strömgren, son of Prof. E. Strömgren, director of the Copenhagen Observatory, describes in *Astr. Nach.*, No. 5406, some experiments that he has made in this direction, using the very sensitive photoelectric cell which is now widely employed for stellar photometry. The current through the cell is so weak that amplification of the order of 10^8 is necessary to operate a chronograph. The widespread use of wireless telephony has gradually brought about improved methods of amplification. Broad occulting bars in the focal plane of the telescope take the place of spider lines; the disappearance and reappearance of a star is automatically recorded.

Successful experiments have already been made on α Arietis (mag. 2·2) and the theoretical feasibility of the method is thus demonstrated; but it is doubtful whether it could be carried below magnitude 5. Moreover, there would seem to be a danger of re-introducing magnitude equation, which has been practically eliminated by the use of the travelling-wire micrometer.

MEASUREMENTS OF RADIATION IN THE SOLAR CORONA.—An important series of measurements of solar corona radiation were taken during the total eclipse of January 24, 1925, by E. Pettit and S. B. Nicholson, who describe their work in the *Astrophysical Journal*, vol. 62, p. 202. The instrument used was a thermocouple placed at the focus of a reflector 50·5 cm. in diameter. A rock-salt window was used for the thermocouple, but observations point conclusively to the fact that there is no appreciable radiation of longer wave-length than 5·5 μ from the corona, so that, in the future, quartz or glass windows may be used without loss. Photometric measurements of direct photographs of the corona were also made, with the object of investigating the distribution and total amount of the radiation. These results were calibrated and expressed in absolute units by comparison with the radiometer measures at selected points. The total light from the corona as measured in this manner was found to be $11{\cdot}2 \times 10^{-7}$ that from the whole sun, or 0·52 of the light received from the full moon at mean distance; one-half of this light coming from a zone extending only 3′ from the limb of the sun. There seems to be very little hope of detecting the corona by radiometer measures without an eclipse, unless the amount of scattered sky-radiation can be reduced to at least 1 per cent. of its value, as observed on Mount Wilson.

Research Items.

The Origin of the American Indian.—In the Smithsonian Report for 1923 (dated 1925), Dr. Aleš Hrdlička, after setting forth the grounds for his view that the American Indian is a race, homogeneous on the whole, which penetrated the continent from Asia through the north-west in relatively modern times, goes on to discuss the chronology of this intrusion and the relative priority of the various types of the Indian race. He points out that the remains, archæological and skeletal, of north-eastern Asia are of no great antiquity, but correspond generally to those of the Old World Neolithic age. The palæolithic remains of the Yenisei and north-western China are thousands of miles away from the point where man crossed to America. This leads to the presumption that man did not cross over before late Palæolithic or early Neolithic times This would give a date of about ten or at most fifteen thousand years ago. Even if the unlikely hypothesis were accepted that man of north-eastern Asia had an independent development from European late Palæolithic or Neolithic man, his advent from southern Asia could not have been earlier than if he had come from the west. Mass migration being impossible owing to the difficulties of climate and food supply, the people must have passed over in small groups. Of these, the first would be the dolichocephalic Indian represented by the Algonquian, Iroquois, Sioux, and Shoshonean stocks which spread to Tierra del Fuego, including the Lagoa Santa race. Next came the "Toltec" type marked by brachycephaly, settling along the north-west coast and reaching as far as Peru. Later came the Eskimo and Athapascan, the former spreading over the far north and becoming the most highly specialised of American types, while the Athapascan, a virile brachycephalic type which may have preceded the Eskimo, is the most closely allied of all to the prevailing Mongolian type of north-eastern Asia. The path of the Athapascan was blocked and they remained in Alaska, except for a few who passed along the west coast to Mexico, where they left the Hupa, and to New Mexico, Arizona, Texas, and tracts of northern Mexico, where they are known as the Apache.

Prehistoric Amber Routes in Europe.—The relative rarity of amber, and the peculiarity of Baltic or northern amber generally owing to its high content of succinic acid, has opened an important line of archæological research in tracing ancient trade routes, based on discoveries of amber, between northern and southern Europe. In the *Geographical Journal* for December, Mr. J. M. de Navarro gives some of his conclusions. Evidence is not sufficient to warrant the assumption that there was a transcontinental trade in amber prior to the Bronze Age. Before that time the appearance of amber in the south was sporadic, and it probably came by sea. In fact, it was not unlikely the opening of the amber trade that led to the introduction of bronze to the north. During the middle Bronze Age, southern and western Germany seem to have played a larger part in the trade than Italy, yet it was probably through Italy that Baltic amber reached the Ægean world. There is not sufficient evidence to say that it came by way of Russia. During the early Iron Ages, the commerce with Italy grew, and consequently Italian influence in northern Europe was more direct. Italian amber was exploited at that period, but analysis of specimens warrants the belief that more of the amber in Italy came from the north, while a certain amount of inferior Italian amber was traded in Switzerland. Mr. Navarro believes that the amber trade culminated about the middle of the seventh century B.C. After that the eastern superseded the western routes and the trade lost importance.

Climatic Changes and the Wegener Theory.—The Wegener theory receives warm commendation in an interesting article by Dr. G. C. Simpson on "Climatic Changes" in the January issue of the *Nineteenth Century*, on the ground that it "solves so many meteorological problems that it is difficult for meteorologists not to accept it." The most serious of these problems is the uniform world-wide climate during the Jurassic claimed by Prof. A. C. Seward from the plant evidence. This view Dr. Simpson describes as "entirely inexplicable" to the meteorologist. It is also inexplicable to the geologist in face of the evidence by the Jurassic faunas of well-marked climatic zones parallel to those of the present day, and of the refrigeration of the Jurassic climate toward the polar regions. The reef-building corals, for example, were then prolific in tropical and subtropical seas, but gradually disappeared toward the north. Dr. Simpson discusses the evidence for recent changes of climate, and agrees with Prof. J. W. Gregory's conclusions that there has been no progressive desiccation or permanent change of climate of the earth during the past 3000 years, though there have been local variations greater than those of the Brückner cycle. Dr. Simpson states that all subsequent work has confirmed Brückner's 35-year climatic oscillation; but as the irregular local changes exceed the Bruckner variation, it is only apparent in records over an extensive area. Dr. Simpson suggests that the oscillation should be called the Brückner groups of cold and warm years rather than a cycle.

Functional Diseases of Apples in Cold Storage.—The Food Investigation Board publishes as Special Report No. 23 ("Functional Diseases of Apples in Cold Storage." By Franklin Kidd and Cyril West. Pp. vi + 15 + 13 plates. London: H.M. Stationery Office, 1925. 1s. net), a very useful summary of the various diseases known to occur to apples in cold storage. This report is based upon a paper by Drs. Franklin Kidd and Cyril West which was published in the *International Review of the Science and Practice of Agriculture*, which is now brought up-to-date and reprinted as a special report accompanied by an extensive series of photographs greatly facilitating recognition of the various diseases. Basing their views in part upon causal conditions involved in orchard conditions or cold storage practice, and in part upon methods of control, the authors recognise the following main types of disease: (1) Apple scald, a browning of the skin of the apple, a disease of the green skin, to which red and yellow skins are very resistant, which can be controlled by very efficient aeration or, still better, by wrapping the apple in a tissue paper that has been soaked in mineral oil. American investigators suggest that this disease is due to the accumulation of esters at the apple surface which are volatilised with efficient aeration or absorbed by the mineral oil. (2) Internal breakdown, a browning of the flesh of the apple which can be controlled by storing at somewhat higher temperatures than 32° to 34° F. (3) Brown heart, caused by excessive accumulation of carbon dioxide during storage (see Nature, April 18, 1925, p. 584), which is avoided by preventing accumulation of carbon dioxide so high as 8 per cent in the storage atmosphere. (4) Frost injury, usually local unless freezing has been severe. An interesting point recorded here is the relatively severe damage that is caused by bruising when the apples are in the frozen condition. The freezing point of the majority of apples appears to be between 28° F. and 30° F.

THE BRITISH FRESHWATER PEARL MUSSEL.—A short while ago (NATURE, July 25, 1925, p. 148) we directed attention to Part I of Mr. J. Wilfrid Jackson's excellent address to the Conchological Society on "The Distribution of *Margaritana margaritifera* in the British Isles." Part II., now before us, which was announced to deal with the past history of the mollusc, does not, however, attain the same standard of excellence or add much to what little was known on the subject. The author points out that there is no definite proof of the occurrence of Margaritifera in pre-glacial times, and concludes that the species owes its presence to dispersal since glacial times, spreading gradually as the glacial conditions were passing away from areas untouched by the ice-sheets and gradually attaining its present distribution. Mr. Jackson summarises and discusses at some length the opinions of a limited number of writers on the glacial period and seems to conclude in favour of the post-glacial age of the greater part of the British fauna and flora. This to one with some fifty years' acquaintanceship with the subject has a distinct flavour of antiquity about it.

COLOUR VARIATIONS IN PARTRIDGES.—An exceedingly instructive series of colour variations in the red-legged partridges, *Alectoris rufa* and *A. saxatilis*, are described by Messrs. W. and G. Bateson (*Journ. Genetics*, vol. 16, No. 1). The "bright" variety of *A. rufa*, known as *melanocephala*, is represented by four specimens in the British Museum, all from the west of England, where four others have been seen. This form is also known from two records in different localities in Spain; and three specimens of the same variation in *A. saxatilis* were examined in Swiss museums, having all been taken within a radius of thirty miles. A "dull" variety of *A. rufa* is described under the name *obliterata*. It has a more nearly uniform coloration and is represented by three male specimens, all from the east of England. A black-headed species exists in Arabia under the name *A. melanocephala*, and this may be factorially significant. The dull, normal and bright forms are regarded as forming a series showing the progressive spread of barring. They are compared with the varieties of North American flickers, Colaptes, and with the barred patterns of the quagga and its relatives. As with Colaptes, a consistent factorial analysis of the differences is impossible without breeding experiments, because the colour-changes in different pterylæ appear to be, at least in part, independent of each other. The same problem is involved here as in the origin of many species which differ in several features of their colour patterns. Many South American parrots and parrokeets show similar differences, and it is to be hoped that some one will undertake breeding experiments with them, which might throw much light on the nature of all such variations.

THE ANATOMY OF PILA.—Vol. 8, No. 3 (1925), of the *Memoirs of the Indian Museum* is devoted to a description, by Dr. B. Prashad, of the anatomy of the common Indian apple-snail, *Pila globosa*, one of the Ampullariidæ which inhabits tanks, ponds, lakes, streams, and ricefields in the Gangetic plain, being particularly abundant where there is a large quantity of succulent aquatic vegetation. The various systems of organs are carefully described and references made to the histology. The functions of most of the organs are briefly noticed, *e.g.* the methods of respiration, aquatic and aerial, and short biological notes are added. The memoir will be found useful for comparative purposes.

CARBOHYDRATE/NITROGEN RELATION IN HORTICULTURE.—The *Journal of Pomology and Horticultural Science* for December contains an interesting review of recent American investigations on the importance of the carbohydrate/nitrogen balance in the plant, upon processes of growth and reproduction, which is written by Henry W. Hooker of the University of Missouri, who is himself an active worker in this field. This ratio is somewhat vague in connotation; carbohydrate is commonly used to include both insoluble polysaccharides such as starch, and reducing sugars, but not substances entering into the skeleton of the plant; there is some discussion as to whether soluble, insoluble or total nitrogen figures are more relevant. By various practical methods, as manuring, girdling, pruning, root pruning, and so on, this ratio can be definitely disturbed and in terms of the disturbance the effects upon growth and reproduction interpreted, though it is evident that the metabolic changes may be associated with, and yet not causal in relation to, growth and developmental changes. In fruit trees it has now been clearly demonstrated that in different parts of the tree this ratio may have a very different value and that the initiation of flower buds is associated with relatively high carbohydrate, whilst, on the other hand, fruit development seems associated with a rise in nitrogen in the fruit-bearing spurs.

THE ORIGIN OF THE ALPS.—In a paper recently read before the Royal Geographical Society, Prof. L. W. Collet gave a summary of recent ideas with regard to the evolution of the Alps. In a series of diagrams, to be published later in the *Geographical Journal*, he showed that in the embryonic Alps the foreland and hinterland of the chain constitute the boundaries of the great Alpine geosyncline diversified by included geanticlines. Through Carboniferous and Jurassic times these boundaries closed on and compressed the geosyncline like the jaws of a vice. The two geanticlines have developed into the two dominant nappes of the Alps, Great St. Bernard and Dent Blanche. Prof. Collet accepts as proved the forward drive of the hinterland towards the foreland. These conclusions, he points out, are in support of the Wegener hypothesis and indicate a northward drive of Europe, producing a distension to which the Mediterranean basin is due.

THE SPECIFIC HEAT OF ROCKS.—The effects of heat upon rocks are important not only geologically but also from the point of view of their fire-resisting properties. A valuable investigation which should not be overlooked has been carried out by T. Okaya, and the results are published in the *Japanese Journal of Astronomy and Geophysics*, vol. 3, No. 1, 1925. The specific heats of seventy-one different rocks are given, with a careful petrological description of each of the specimens tested. It is shown that the specific heat depends mainly on the chemical composition, but also in part on the structure. For practically all rocks the value lies between limits of 0·1 and 0·3. Among igneous rocks those rich in soda have higher values than those rich in potash. Sodic andesites, for example, range from 0·24 to 0·28, whereas potassic andesites range from 0·14 to 0·20. Crystalline limestones vary widely: from 0·19 for those poor in calcite to 0·26 and higher in the case of saccharoidal calcite marbles. Results are also recorded for tuffs and granites, and the paper is illustrated by eighteen excellent photo-micrographs.

AN AIR-PRESSURE SOUNDING MACHINE.—In the November number of the *Hydrographic Review*, there is a description of a self-recording sounding machine which depends on balancing the pressure of water on the sea-bottom by an equal pressure of air. The portion on the sea-bottom is an armoured sounding cable containing a flexible rubber tube. The lower end of the cable is provided with a jointed armoured covering which permits ready bending and promotes durability. The inboard end is secured by an air-tight joint to the hollow axle of the winding drum. An air-pressure-pipe connects the axle, and therefore the tube of the sounding cable, with a pressure gauge on the bridge and with the compressed air reservoir. The recording devices consist of three dials and a bathygraph. The depth, at any moment, can be read on one of the dials. The other dials show the amount of cable out and the pressure in the air reservoir, while the time is recorded on a bathygraph. In practice the pressure in the reservoir is kept slightly higher than any water pressure expected, and the excess pressure is reduced by the escape of air from the bottom end of the sounding cable until the water pressure is balanced.

Stokes's Theory of the Aberration of Light.—The issue containing parts 11-14 of Vol. 58 (1925) of the *Rendiconti of the Royal Lombardy Institute of Science and Letters* includes a paper by Prof. G. A. Maggi replying to the objections raised to Stokes's theory of the aberration of light by Prof. Eddington in his communication on "Ether Drift and the Relativity Theory" published in Nature of June 6 last. As regards the first objection—that the ether, with a velocity which is zero at sea-level and 10 kilometres per second at the height of Mount Wilson, would possess a rapid rotational motion, whereas Stokes showed that the movement of the ether should be irrotational—Prof. Maggi points out that actually Stokes postulated the irrotational movement to deduce his formula and that hence arose a difficulty indicated at the time by Lorentz in his paper on "Stokes's Theory of the Aberration in the Supposition of a Variable Density of the Ether" (*Proceedings of the Royal Academy of Sciences*, Amsterdam, 1898–1899, p. 443). The second and more serious objection advanced by Eddington is to the effect that, in contradiction to the more elementary notions of astronomy, the formula of Stokes indicates a variation of the aberration with the altitude. In this connexion Prof. Maggi observes that Stokes's formula furnishes the effective deviation, with respect to the terrestrial globe, of the light emitted from a star, from which, allowing for the degree of drag of the ether at any altitude, the aberration at that altitude is deduced.

Release of Pressure in Coal-dust Explosions.—"The Effect of Release of Pressure on the Development of Coal-dust Explosions" is the subject of the second joint publication by the Safety in Mines Research Board and the United States Bureau of Mines (London, H.M.S.O., 3*d*. net). It describes a series of trials carried out at Eskmeals under Dr. R. V. Wheeler, the Director of the Station, and Mr. H. P. Greenwald of the Bureau of Mines staff. The experiments were made in the large steel gallery 750 feet long, open at one end and (normally) closed at the other. A cannon fixed 200 feet from the closed end was fired into a pile of fine coal-dust placed in front of it. Between the cannon and the open end, 550 feet away, fine dust was strewn partly on side-shelves and partly on the floor; no dust was laid behind the cannon. Along the gallery timing-screens and pressure gauges were fixed. The release of pressure was effected by substituting plates with circular holes cut in them for the solid plates which normally closed the gallery at three different places. (1) In the first place the release was made in the end plate 200 feet behind the cannon. When this was closed the maximum velocity of flame recorded near the mouth of the gallery was 2660 feet per sec. with a maximum pressure of 73 lb. per sq. inch. When this plate was a quarter open, little difference was observed; but with the end half open the pressure recorded was much less, although the flame came out at both ends of the gallery. With the rear end quite open the flame travelled slowly and only 2 lb. pressure was recorded. (2) When the openings for release were made just in front of the cannon, two small openings of one-sixteenth the area of the gallery had little effect on the velocity and pressure; but two one-eighth openings reduced the velocity to nearly one-quarter and the pressure to 3 lb. On moving the cannon just in front of the two one-eighth openings the velocity was high and the pressure rose to 23 lb. (3) When the openings were 200 feet in front of the cannon, the effect was to accelerate the initial flame, though the pressure recorded near the open end was not so high as when there was no release—and appeared to diminish as the flame proceeded. The nearer to the firing-point the release of pressure can be made, the greater is its effect in preventing a serious dust explosion.

Alchemical Secret Names.—E. Wiedemann and J. Ruska have accomplished a very useful piece of work in giving a list of some Arabic alchemical "Decknamen" in a recent number of the *Beiträge zur Geschichte der Naturwissenschaften* (Sitzungsber. d. Physikalisch-Med. Sozietät in Erlangen, Band 56, 1924) It is well known that the Greeks, Syrians, Persians, Arabs, and others who, during 2000 years, busied themselves with alchemy, used "technical" or secret names for the substances they used in their operations These names sometimes refer to noticeable properties of the bodies concerned (*e.g.* mercury, "the volatile slave"; copper, "the green one"; and so on), and sometimes are derived from mystical or religious associations, as when the metals are called by the names of the planets. Very often, however, they are purely arbitrary, so far as can be judged at the present day. The existence of this peculiar and variable system of nomenclature renders the translation of early chemical texts a matter of great difficulty, and the appearance of any list of synonyms—especially from the pen of Wiedemann and Ruska—is a matter for congratulation. The present paper is based mainly upon a manuscript work (Berlin, Ahlwardt's catalogue, No. 10361) of the celebrated poet, statesman, and alchemist Al-Tughrā'ī, entitled "The Book of the Precious Stone, upon the Art of the Elixir," but other sources have been drawn upon as well. First of all, the various names of the seven metals are given—no less than 23 for gold and about 60 for mercury!—then come the names of the seven "spirits" (mercury—also classed with the metals,—sal-ammoniac, realgar, orpiment, "yellow sulphur," "red sulphur," and "white sulphur"). Among the most interesting are the following: *Al-Kātib* (the scribe) and *Ḥayatu'l-Ajsād* (life of the metals), for mercury; *Al-Milḥ al-Ṭayyār* (the flying salt) and *Al-Filfil al-Armanī* (Armenian pepper) for sal-ammoniac; and *Ṭair Suqrāṭ* (the Bird of Socrates) for sulphur. A similar vocabulary, but with a larger proportion of Greek names, is given by the thirteenth-century author Abu'l-Qāsim al-'Irāqī in his book "Al-Kanz al-Afkhar," a MS. of which is preserved in the Royal Library at Cairo. Such lists are not only interesting in themselves; they also afford useful evidence concerning the transmission of chemical knowledge from one nation to another. Very noteworthy is the large number of Persian words used by Muslim chemists.

The Mathematical Association in Conference.

THE annual meeting of the Mathematical Association was held at the London Day Training College on January 4 and 5, with Prof. G. H. Hardy presiding. The report of the Council records continued growth in membership, and continued activity on the part of committees. The programme of the meeting consisted of three lectures and two discussions, in addition to the president's address.

Prof. E. N. da C. Andrade, whose subject was atomic structure, described the decomposition of a line spectrum into series, and Bohr's theory of the relation of these series to the constitution of the atom.

A lecture on modern theories of integration was in the nature of an experiment, and was brilliantly successful. After recalling the dual rôle of the integral in elementary work, Mr. Carey Francis showed the limitations imposed by any definition of the definite integral in which the only division of the range which is contemplated is a division into subintervals He explained how the measure of a set of points extends the conception of the length of an interval, and introduced the Lebesgue integral and the Stieltjes integral as natural results of subdividing the range of integration into sets of points of any kind instead of into intervals only. Mr. Francis' achievement in making clear the nature and purpose of a mathematical method that was outside the curriculum in the student days of the majority of his audience seems to indicate a new and valuable function of the Association.

A forcible speech by Mr. E. R. Brown opened a discussion on the *Mathematical Gazette*, the organ of the Association; the remarks of different speakers emphasised the variety of tastes for which an editor may be asked to cater, without showing very clearly the sources from which he can draw.

Dealing with the measurement of intelligence, Prof. C. Spearman first illustrated the difficulty of reaching agreement either on a simple definition of intelligence or on the group of elementary qualities to be included in a composite definition. He afterwards explained the discovery that over a very wide range the observations can be systematised by the recognition of two factors, one which can be regarded as a measure of general intelligence and another which depends on the subject in which the individual is being tested.

The president's address was entitled "The Case against the Mathematical Tripos." Examinations have their place in education up to a certain point as natural and effective tests of industry and of the ability to learn and to reproduce, but the claim made for the Tripos has been that it assesses qualities of a higher order. Because of this claim and of the prestige of the Tripos, training for the examination has been substituted for genuine mathematical education, with the mischievous result to the individual that at any time it has been possible to obtain the highest honours while completely ignorant of all the broad developments of the previous thirty years, and to the nation that in no subject except music has the international position of England been so deplorable throughout two hundred years as in mathematics. Not only is it difficult to present in theory a plausible defence of the claim made for the Tripos, but in practice, position in the Tripos is ignored in all but an insignificant fraction of appointments, and if the Tripos is less harmful to English mathematicians now than fifteen years ago, that is because there is no distinction now which a good student does not obtain as a matter of course. Convinced that the best that can be said for the Tripos is, that so long as no attention whatever is paid to it either inside the University or outside, its ill effects are negligible, Prof. Hardy advised mathematicians at Cambridge deliberately to lower the standard at every opportunity, and so to reduce the examination to an absurdity the abolition of which must be only a matter of time.

Time was allotted for discussion of a "Report on the Teaching of Mathematics to Evening Technical Students," which has just been prepared for the Association; unfortunately, the report was not in the hands of members, and speakers could refer only to a synopsis distributed at the meeting, but interesting views were expressed on such matters as the value of deductive geometry for these students, and appropriate methods of introducing logarithms and the exponential function.

Agricultural Education in the United States.[1]

DURING the last half-century the importance of agricultural education has been increasingly recognised in America, until now every State has one or more agricultural colleges, forming a group of institutions occupying a prominent position in the field of education. During the decade 1910–1920 development was extraordinarily rapid, and very large sums of money were appropriated in many States for the provision of new agricultural buildings, the purchase of land, and the endowment of educational programmes. The colleges have had a long struggle for recognition, but have demonstrated their value and are now in such a position, financial and otherwise, that their future usefulness is assured. The immediate need is for trained teachers, investigators, and administrators, and in response to this, graduate work in agriculture has developed with amazing rapidity during recent years, though in certain colleges it is still seriously handicapped by lack of funds and accommodation. At present the full agricultural course extends over four years, but there is a suggestion to extend this to five in some cases for the purpose of specialised training. In many colleges the curricula have been steadily changed in order to keep abreast of the modern requirements of agricultural education, though there are still some in which the work is too largely restricted to methods of production, resulting in a narrowed outlook.

The field of work covered is very wide, ranging over at least a dozen branches, which, however, are not rigidly separated but dovetail into one another to some extent. All branches have developed from small beginnings, shaping themselves according to the needs of the time, with the result that some subjects which were originally an integral part of one branch are now dealt with more fully and adequately by others. Agronomy was initially defined as covering that part of the general field of agriculture devoted to climate, soils, fertilisers, and farm crops, but it now tends to deal with the more fundamental and far-reaching problems of soil physics and chemistry, plant physiology, and plant genetics. It is claimed that the instruction in agronomy has had much to do with securing the improved crop production of the United States in recent years. Horticulture has almost always had a separate existence in the colleges, but with the growth of various interests, certain branches have developed until now they are treated independently, pomology and vegetable gardening being notable examples. With the better recognition of the importance of the forests to the nation, the instruction of forestry has advanced from exclusive concern with questions of afforestation to consideration of the vital problems of the proper protection, management, and perpetuation of existing stands of timber. The land grant colleges recognise their opportunity and responsibility to train the leaders with the necessary technique and with the broad outlook which will enable them to develop sound public policies of dealing with the forests and to establish right standards of practice. The general scheme of education keeps in view both the scientific and practical aspects of agriculture, and endeavours to emphasise the entire interdependence of the two. In addition to the branches already mentioned, special sections are devoted to soils and fertilisers, plant pathology, entomology, animal, dairy, and poultry husbandry, veterinary education, and agricultural engineering.

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[1] Land Grant College Education, 1910–1920 Part III.: Agriculture. Edited by W. C. John. U.S. Bureau of Education Bulletin, 1925 No. 4. Pp. 105.

It is recognised that the four-year college course is not sufficient to supply the demand for trained workers on the land, partly because so large a percentage of graduates draft off into other occupations, as teachers, county agents, scientific workers, etc., and partly because a large proportion of those intending to farm cannot afford the time or money for a full college training. To meet the needs of the latter class, various types of short courses have been developed covering the various sections of the community concerned. The older boys and girls are catered for by special agricultural schools, farmers are provided with short courses extending over a few weeks only, at the slackest times of the year, and short schools are held for training specialists in such subjects as dairying, cotton culture, and ice-cream manufacture. In addition, courses in agriculture and horticulture are run for one, two, or three years, primarily for young men and women who intend to make farming their life work. Many problems have arisen in the development of these short courses, and special endeavours are made to solve them in such a way as to render the courses an integral and valuable part of the whole educational scheme.

During recent years a very marked development has taken place with regard to the professional training of teachers in agriculture. Special legislation has provided grants from Federal funds for the purpose, on the condition that equal sums are found by the States participating. The expenditure in this respect increased from 121,244 dollars in 1918 to 651,792 dollars in 1921, the growth of the work being so rapid that it was difficult for the land grant colleges to secure adequately prepared instructors for the purpose. Still more recently a demand has developed for courses in education designed to meet the needs of college instructors, and there seems little doubt that this part of the work will increase in relative importance The same may be said of the agricultural extension work, which has steadily increased until in 1921 more than 18 million dollars were expended thereon, directly aiding the improvement of the farm and home practice of more than two million workers directly connected with the land, the whole of the extension work in 1920 costing 75 cents for each 1000 dollars of gross returns from agricultural production in the United States.

The Rainfall of Dry Periods in Relation to Water-power Schemes.

IN all questions relating to water-power schemes, some estimate of the water available is of first importance. Most schemes involve the storage of water in reservoirs, the size of which depends on the proposed draw-off compared with the run-off from the gathering ground in a dry period. Undoubtedly measurements of stream flow afford the best hydrological data upon which to base calculations. Such data are, however, often too short to give the average over a long period or the flow in the all-important dry period. Thus to a large extent calculations have to be based upon measurements of rainfall, compared where possible with gaugings of stream flow. It is, therefore, important to consider the relation of the average rainfall (1) to that of the period for which stream gaugings are available, and (2) to falls in dry periods in that area.

An investigation has been carried out on this subject by Capt. W. N. McClean,[1] who has analysed the monthly and annual rainfall figures for the fifty years 1871 to 1920 for thirty-five stations in Scotland. This mass of data is marshalled into a convenient graphical form, the unit of measurement of rainfall being expressed throughout in inches per annum, and the rainfall being plotted as the aggregate excess or deficiency from the average of the whole fifty years. The curves reproduced in the paper make it possible to read off.

(1) The actual rainfall of each calendar month and year;

(2) The lowest rainfall of each month and year; and

(3) The predicted lowest falls of periods of various lengths based on (2) above.

The fifty years, 1871 to 1920, were remarkable for the run of wet years in the 'seventies, the years 1872 and 1877 being the wettest in the series. The rainfall of the years 1886 to 1889, especially that of 1887, provided in many cases the lowest values in the period under discussion and would have severely taxed the storage capacity of the reservoirs. Outside the series, the year 1870 was as dry as 1887 over Scotland as a whole, while 1921 was noteworthy for the lowest annual totals on record in parts of the east of Scotland. Had these years, 1870 and 1921, been included in the analysis, lower values would certainly have been obtained in some instances and the smoothed enveloping curve of predicted values might have been modified.

One of the important facts brought out by the paper is that the rainfall at some stations is more variable year by year than at others, and this characteristic persists throughout the fifty years. The mean deviation of annual rainfall from the average is known to exceed 12 per cent. in central and south-eastern Scotland. This value diminishes towards the coast on all sides, but especially to the north-west, where, in islands to the west of Scotland, the value is only 8 per cent. This small variability factor in the rainfall of parts of Scotland is of considerable importance in connexion with the supply of storage reservoirs. In arriving at the predicted lowest values for each record, a factor is used based on the mean lowest value for the thirty-five gauges. Since there is this marked geographical variation, it would clearly be advantageous to use a factor varying with the geographical position of each individual station.

The curve of lowest predicted values is obtained from the one extreme value of the low rainfall for each of the periods of varying length. It is, however, essential to know the frequency of occurrence of low readings and whether any of them are fortuitous. Such information can be readily obtained from the mean deviation, which takes account of all the deficiencies in the series. This is another reason for including some such measure of the variability of the rainfall in the curve of the predicted lowest values.

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[1] "An Analysis of Scottish Rainfall Records" By W. N. McClean. Pp. 19+16 plates. (The Institution of Water Engineers, December 1925.)

This exhaustive analysis of Scottish rainfall is of particular importance in that the Western Highlands of Scotland provide a promising field for the further development of water-power schemes, having a large area with an average annual fall of more than 80 inches (reaching locally 150 inches) and a smaller factor of variability than most other areas in Great Britain.

The Spider Crabs of America.[1]

MISS RATHBUN has completed a very beautiful systematic monograph on the American spider crabs. It is a work of enormous labour, for no less than seventy-nine genera and nearly three hundred species are described, with minute details of their distribution and lists of the specimens examined from all localities. The figures are good photographs or clear diagrams and occupy nearly half the book, which is a most important contribution to the study of carcinology, and will be extremely useful to all systematists.

The companion volume is "The Grapsoid Crabs of America," forming Bulletin 97 of the United States National Museum, 1918, and here is to be found an introduction serving for both volumes, which are to be followed by others. The collections in the United States National Museum, embracing many hundreds of specimens, form the basis of both bulletins.

We have in the present volume a handbook for the study of American spider crabs which will be indispensable to workers in all countries. Some of these crabs have an extremely wide range of distribution; such are *Hyas araneus* and *Hyas coarcticus*, aptly termed "toad crabs," both of which are common on British coasts. *Hyas coarcticus*, which was originally described by Leach from British seas, is shown to have also a wide vertical range, extending from low water to (exceptionally) 906 fathoms.

The love of spider crabs for decoration is remarkable, and although in a work of this kind there is no room for details as to habits, still much may be learnt from it as to habitat and adaptation. Whether the animals actually decorate themselves with foreign substances or, without using them, are so like their environment that decoration is unnecessary, they are all so perfectly adapted to their surroundings that even in dead specimens one can usually recognise the kind of ground on which they live. The members of the Majidæ are the most important of the "masking crabs," but even among these there are some which do not cover their bodies with extraneous matter. Thus we have the bright red *Thoe puella* in the fringing shallows living on broken pieces of coral which have portions of sponge scattered over them of a similar colour to the crab; and the hairy *Mithrax verrucosus*—the hiding-place of which is in rocky holes covered with madrepores—which only comes out to feed at night. In the smaller family, Parthenopidæ, there are *Heterocrypta granulata*, the "pentagon crab," living on shingly bottom, bearing a striking resemblance to a freshly broken chip or flake of stone, and *Parthenope serrata*, which lives in the sand in shallow water with only the rostrum, eyes, and afferent apertures exposed, these apertures being situated between the base of the finger and the margin of the orbit.

There are very good diagrams showing the nomenclature of the parts as used in the monograph, and the descriptions of the crabs and the keys are all clear and easy to understand.

University and Educational Intelligence.

ABERDEEN.—Ordinances for the establishment of chairs in forestry and bacteriology have been approved of by Order in Council.

The Right Rev. E. W. Barnes, Bishop of Birmingham, has been appointed Gifford Lecturer for the period 1926–8.

CAMBRIDGE.—Mr. G. E Briggs, fellow of St. John's College, has been reappointed as demonstrator in plant physiology. Mr. Briggs has in the past done effective research on carbon assimilation and growth.

The Royal Commission has issued amended regulations governing the initial appointments to be made under the new statutes.

Certain amendments to the regulations of the mechanical sciences tripos have been brought forward. The proposed changes are chiefly concerned with the regrouping and amendment of the "B" (advanced) papers, the special function of which is to grade the candidates.

The local nominees to the first committee of management of the new Polar Institute consist of the present Vice-Chancellor, and three antarctic explorers—Messrs. Debenham, Priestley, and Wordie. The Council of the Royal Geographical Society has nominated Dr. H. R. Mill as its representative.

A Gordon Wigan prize of 30*l.* has been awarded to Mr. F. H. Constable, fellow of St. John's College, for chemical research on "The Nature of Catalytic Action."

ST. ANDREWS.—The degree of D.Sc. has been conferred on Mr. James Forrest, lecturer in natural philosophy, University College, Dundee, for a thesis entitled "Magnetic Quality in Crystals; Part I., Magnetic Discrimination of Molecular Lattices; Part II., Stability of Molecular Lattices."

STERLING Fellowships for Research in the Humanistic Studies and the Natural Sciences at Yale University Graduate School have been established by a gift of 1,000,000 dollars from the trustees of the estate of the late John W. Sterling to stimulate scholarship and advanced research in all fields of knowledge. They are divided into two general classes: Research or Senior Fellowships, candidates for which must be of the standing of the Ph.D. degree; and Junior Fellowships, candidates for which must be well advanced in their work towards the Ph.D. degree. The annual stipends of the former range from 200*l.* to 500*l* or more, dependent upon the character of the proposed investigation, and of the latter from 200*l.* to 300*l.* The fellowships are open equally to graduates of Yale University and other approved colleges and universities. Applications for the fellowships should be addressed to the Dean of the Graduate School of Yale University, New Haven, Connecticut, for Junior Fellowships, by March 1, and for the Senior Fellowships by April 1.

THE December number of the *University Bulletin* of the Association of University Teachers contains an article by Dr. Alex Hill, of the Universities

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[1] Smithsonian Institution: United States National Museum. Bulletin 129: "The Spider Crabs of America." By Mary J. Rathbun. Pp. xx+613 +283 plates. (Washington: Government Printing Office, 1925.) 2 dollars.

Bureau of the British Empire, on the promotion of "Interchange" of university teachers and students. By this phrase is meant temporary migration or short visits by teachers and students from the universities of Great Britain to those of another country for study, research, or teaching. The article traces the growth of the movement and its connexion with the growth of specialisation among universities from the year 1903, when, at a conference of universities, Lord Bryce pointed out that special opportunities of studying mining, forestry, and other branches of applied science were offered by the universities in the overseas dominions. The migration of British graduates to U.S.A. has received a substantial impetus in the past few years through the establishment of fellowships financed from America—especially the Commonwealth Fund fellowships founded last year. As regards migration of teachers, the article indicates that while the system established in many American universities of granting "Sabbatical" leave—furlough for an academic year after six years of service as professor—coupled with grants by the Institute of International Education of travelling allowances, makes the migration of American professors to Europe comparatively easy, the absence of any corresponding system in universities in Great Britain stands in the way of further development of migration by their professors, though it does not prevent them from paying visits of a few days' duration to continental universities. The faith of our universities in the benefits of interchange of professors has not yet availed to make them adopt the principle of the Sabbatical leave, even to the extent of announcing their willingness to grant such leave in the event of funds being provided to meet the expense involved.

THE prospectus for the year 1926–27 of the Imperial College of Tropical Agriculture, Trinidad, embodies a new feature in the form of the Principal's report, and a register of present and past students of the College has been inserted. The College has entered upon a new phase as the new buildings, the foundation of which was laid in January 1924, have now been opened by the Governor of Trinidad, and are in use. The Principal's report covers the academic year 1924–1925, the third year in the life of the College, and the first year of the term of office of the new principal, Dr. H. Martin Leake. The report indicates steady and useful progress both in the number of advanced and diploma students and in the amount and character of the research and investigation work that has been carried on. Full details of the courses of study in agriculture, botany, chemistry and soil science, economics, mycology, tropical sanitation and hygiene, veterinary science and zoology and entomology are given, and it will be seen that full provision is made to enable students to gain a very sound knowledge of tropical agriculture in all its branches. Reference is made to a hostel which is to be provided for students as soon as possible. A hostel will be needed all the more now that the Colonial Office has arranged to send students, under the Milner Scholarship Scheme, for a year's training in tropical agriculture before they take up their appointments in one of the Colonial agricultural departments. Though the importance of a hostel is fully realised by the governing body, funds, we understand, are not yet available for the purpose, and it is very desirable that Government and private benefactions should be made towards this very essential need of the College. The Imperial College has, we feel sure, so great a future before it that we commend the institution to the notice of all those who take an interest in the agricultural development of British Colonies.

Contemporary Birthdays.

January 29, 1845. Sir Robert Elliott-Cooper, K.C.B., Past. Pres. Inst.C.E.

January 30, 1851. Dr. Henry Ogg Forbes, F.R.G.S.

January 31, 1868. Prof. Theodore W. Richards, For. Mem. R.S.

Sir ROBERT ELLIOT-COOPER, born at Leeds, was educated there at the Grammar School, the headmaster of which at the time was Dr. (afterwards Bishop) Barry. Sir Robert's engineering pupilage began with the firm of Messrs. John Fraser of Leeds. Fifty years ago he settled in London to take up professional work. In 1912 he succeeded Prof. Unwin, F.R.S., as president of the Institution of Civil Engineers. His inaugural address dealt at length with the railways and works of the civil engineer in the overseas Dominions, the Crown Colonies, and the protectorates of the British Empire, many valuable statistics being brought together. During the War, Sir Robert was chairman of the War Office Committee of the Institution of Civil Engineers. He is a member of the executive committee of the National Physical Laboratory. It is interesting to note that Sir Robert's grandfather, when a young naval officer, sailed with Capt. Cook round the world, and was present at the discovery of Australia.

Dr. H. O. FORBES, traveller, anthropologist, museum curator, was born at Aberdeen. Educated at the city's grammar school, he proceeded to the Universities of Aberdeen and Edinburgh. He is LL.D. of the former. So far back as 1878, Dr. Forbes was exploring in Keeling Islands, Java, Sumatra and Timor, work which led to other undertakings in scarcely known lands. In 1885 he was chief of an expedition to explore Mount Owen Stanley, New Guinea. Director of the Canterbury Museum, New Zealand, 1890–93, he afterwards became Director of Museums to the Corporation of Liverpool. In various capacities he has proved a staunch helper to the British Association. Among many early memoirs, Dr. Forbes is the author of "On the Contrivances for ensuring Self-fertilisation in some Tropical Orchids"; "The Chatham Islands: their Relation to a former Southern Continent."

Prof. T. W. RICHARDS, Nobel laureate in chemistry, was born at Germantown, Pennsylvania. Son of a painter of landscapes and marine subjects, his mother was the author of various poetical works. She it was who conducted in the home Richards's early education, which was continued at Haverford College and Harvard University. Afterwards there was intensive study at Göttingen, Leipzig and Dresden Technical School. Becoming an assistant at Harvard in 1889, Prof. Richards is now Erving professor of chemistry and Director of the Wolcott Gibbs Memorial Laboratory, Harvard, U.S.A. The Nobel prize in chemistry for 1914 was allotted to him in recognition of his exact determinations of the atomic weights of a large number of the chemical elements. At the laureate ceremonies, Prof. H. G. Söderbaum, of Stockholm, said: "The work he has accomplished as a reformer of chemical methods and practices is by no means the least insignificant phase of his achievements." The Royal Society's Davy Medal had been awarded earlier. So too, the Chemical Society's Faraday Medal, given on the occasion of the Faraday lecture. "The solution," said Richards, "of the cosmic riddle is of the greatest importance to humanity, because only through a complete understanding of his own structure and that of his environment can man obtain control of the necessary conditions of his existence."

Early Science at Oxford.

February 1, 1683–4. Mr. Desmasters gave us an account of some experiments lately made by him, concerning ye expansion of Water frozen; he observed, that a cylindricall tube of ¼ of an inch diameter, being filled with water, to ye height of 2 inches, and set to freeze, in a mixture of snow, and salt; ye water, when perfectly frozen, appeared $\frac{1}{11}$ of an Inch above ye marke it stood at before ye freezing began. Another cylindricall tube of almost an inch diameter, being filled with water to ye height of 6 inches, and set to freeze as before; ye water in freezing rose $\frac{3}{8}$ of an inch; he observ'd farther, that when ye water thus set in snow and salt, began to freeze, a great number of small bubbles rose continually from ye bottom for some time. Mr. Ballard has observed of late, that half a pint of water frozen, lost ʒij—ʒij—grviij of ye weight it was of, before ye freezing; this experiment he tried a 2d time; ye success was much ye same, as at ye first. It was then queried, whether water, out of which ye air is pumpt, will rise in ye middle in the time of its freezing? and whether boiled water rises in freezing? Dr. Plot, and Mr. Ballard, undertook to trye these experiments.

Mr. Ballard gave an account of his success in trying some of Mr. Chamar's Experiments; whereas amongst other things Mr. Chamar says that Iron touched will loose its vertue, by being filed; Mr. Ballard says, this is true, if ye Iron be filed *all over*, not otherwise. Dr. Plot shewed some of ye Turkish *Rusma*, and *Alcanna*, which he lately received from Mr. Smith, Student of Christ Church, and chaplain to ye Factory at Smyrna, who wrote of ye use of ye Rusma, the *Alcanna* is ye leaf of a plant, dried, and powdered; which, when steept a night in wine, will die ye nails red; and I suppose ye gentleman means Smyrna, or such like wine, for (as Dr. Plot tells us) it will not succeed with Canary, or Claret.

Dr. Plot then proposed, and it was ordered by ye Society, that an exact account of ye weather should be kept, either according to Mr. Lister's, or some such compendious, method; and that at ye end of this, and other years, ye account of ye weather of preceding years, one or more, should be printed with an almanac for ye year to come.

February 1, 1686–7. An account was communicated by Mr. Musgrave of a way to preserve beef for three quarters of a year, and then half a year more after roasting.—An account of two high tides at London Jan. ye 28th, one 5 hours after the other.—An account of several extraordinary productions of a fœtus, bred out of a cat and a rat; the cat being the dam. This fœtus is now to be seen at the Earl of Abingdon's, as likewise a *Hirco-cervus* bred of a goat and a deer at ye same place. An account of several productions of a colour different from that of their species: e.g. of a white Ouzle or Black-bird, of white mice at one Mr. Tillyard's, an Apothecary in Oxford; of white Woodcocks, Partridges, Pheasants, &c. seen by several of the Society.

February 2, 1685–6. A letter from Mr. Nicholson to Sir Wm. Dugdale concerning the Runic Inscription at Bridekirk was comunicated by Dr. Plot.—A Paper of Dr. Papin's explaining ye use of his Water Engine was also read.

February 3, 1684–5. Two letters from Mr. Cuningham, of St. Leonards College, were read: the latter of these mentions a way used in Scotland for ye cleansing mines of noxious vapors; the miners carry down a candle, in a dark lantern, covered with a wet cloth; then, lying flat on their faces, they, in that posture, kindle, and maintain a fire, which carryes off ye vapors, without injuring ye miners.

Societies and Academies.

LONDON.

Royal Society, January 21.—**R. E. Gibbs**: Structure of α quartz. Investigations on quartz have shown that symmetry and X-ray data enable only partial definition of structure. Intensity measurements and general physical properties of the material must also be studied. Oxygen atoms occupy positions *c*/9 above and below the silicon atoms. Only a small structural change accompanies the transition from β to α quartz, but still the tetrahedral character of β quartz is lost. The structure proposed assumes the crystal to be non-molecular and the oxygen to occupy basal planes as noted above. The silicon atoms seem to move about 0·3 Å.U. from their β-positions.—**N. K. Adam** and **G. Jessop**: The structure of thin films, Pt. vii. Critical evaporation phenomena at low pressures By means of a new apparatus, measurements of the surface pressure of monomolecular films have been made at room temperature, down to 0·01 dyne per cm. At areas greater than about 5000 sq. Å.U. per molecule, the pressures exerted by films of insoluble fatty substances tend to a value within 25 per cent. of that given by the equation $Fa = RT$, R having the same value as in a perfect gas. The divergences from the theoretical values are probably within experimental error. Between 100 and 5000 sq. Å.U. the pressure-area isothermals closely resemble those for liquid and vapour in three dimensions. Expanded films are analogous to liquids, *not* vapours, and there is considerable cohesion between the molecules in them.—**H. J. Gough, D. Hanson** and **S. J. Wright**: The behaviour of single crystals of aluminium under static and repeated stresses.—**C. H. M. Jenkins**. The determination of the vapour tensions of mercury, cadmium, and zinc by a modified manometric method. The apparatus consists of a specially designed manometer, using the material under determination as the observed liquid in this gauge; it can be inserted in a 3-inch diameter electric tube furnace. The pressure on the apparatus is regulated by means of nitrogen, the pressure of which is measured on an independent barometer. The vapour pressure of the liquid is measured over a free surface in the closed end of the manometer by alterations in the pressure of the nitrogen to bring both liquid surfaces in this gauge level. The apparatus is similar to the letter V in shape. One extremity is closed; the other opens into a long straight column bent at right angles to it. Into this column specially shaped pieces are inserted, transforming it into a reflux condenser, which counteracts the diffusion of the nitrogen into the vapour. Values have been obtained for the vapour tensions of mercury, cadmium, and zinc over the range of pressure from 15 to 1500 mm. The boiling-points (760 mm) have been found to be 357°, 767° and 906° C. respectively.—**W. Barlow**: The configuration of the carbon atom and the geometrical relations of this configuration to those of other atoms, as evidenced in the chemical and crystallographic structures of organic chemistry. Pt. i.—**Ursula Andrewes, Ann C. Davies** and **F. Horton**: The soft X-ray absorption limits of certain elements. Investigations have been made of the voltages corresponding to critical values of electron energy associated with some of the longer wave-length absorption stages of seven successive elements, chromium, manganese, iron, cobalt, nickel, copper and zinc. The generally accepted value of an absorption limit, obtained by spectroscopic methods, corresponds not to ionisation of the atom by the detachment from it of an electron in the sub-group concerned, but to the transportation of the electron from the sub-group to the periphery of the atom, *i.e.* to the levels of the most loosely bound electrons The values obtained in this investigation are associated with absorption of energy by electrons in the M sub-groups, the several values obtained for each element being attributed to selective absorption stages, and not to actual ionisation of the atom.—W. L. **Bragg** and G. B. **Brown** · The crystalline structure of chrysoberyl. Chrysoberyl, $BeAl_2O_4$, is analogous in chemical composition to the spinel group of minerals $R''R_2'''O_4$. It is entirely different in its crystalline form, being orthorhombic, whereas the spinels are cubic. It may be supposed that the oxygen ions occupy the greater part of the volume in the crystal, and the metal ions are placed in the interstices between a close-packed assemblage of oxygen ions. A comparison of BeO, Al_2O_3, $BeAl_2O_4$, shows that in each case the oxygen atoms are very nearly in a close-packed hexagonal arrangement and that the distances between atomic centres are almost identical from the three crystals, being about 2·7 Å.U. Each aluminium atom in Al_2O_3 and $BeAl_2O_4$ occupies a position between six oxygen atoms. The hexagonal close-packed lattice can be referred to orthorhombic axes with ratios $\sqrt{2/3} : 1 : \sqrt{3/3}$.—H. G. **Telling**: On a set of quartic surfaces in space of four dimensions, and a certain involutory transformation. Each of the surfaces in four dimensions may be generated by taking three arbitrary skew lines and two arbitrary points, drawing a plane through each of the points to meet the three lines, and then finding the locus of the intersection of the plane through the first point with the plane through the second point. The geometry of the surface then suggests the consideration of, in all, fifteen lines, of which that joining the two given points is one; and then passing through an arbitrary given point of the space, there are fifteen such surfaces, one associated with each of the lines. The paper is concerned with determining the intersection of any two of these fifteen surfaces.—L. F. **Richardson**: Atmospheric diffusion shown on a distance-neighbour graph. The atmospheric diffusivity in Fick's equation has been found by various investigators to increase from 0·2 cm.^{2} sec.$^{-1}$ to 10^{11} cm.^{2} sec.$^{-1}$ as the size of the cluster of diffusing particles increases from 10^{-2} to 10^8 cm. The effect is due to eddies of many sizes acting together. There is apparently no way of modifying Fick's equation in order to describe this phenomenon. But a new mathematical method is here developed, in which, instead of thinking about concentration as a function of position, we think about q, the mean number of neighbours per length, as a function of l, their distance apart This gives a rough average value 0·6 $l^{4/3}$ cm.^{2} sec.$^{-1}$ for the atmosphere, when l lies between 1 metre and 10 km.—T. **Alty**: Some phenomena occurring at the surface of bubbles in water. The surface tensions of water in contact with various gases are compared by the drop-weight method. The weight of a bubble is independent of the gas used if the rate of flow is slow enough. To examine a new water surface, the rate of flow is increased until several bubbles emerge per second. When flowing from the same capillary, the gases form bubbles the volumes of which can be arranged in decreasing order as follows: argon, nitrogen, oxygen, ozone, hydrogen, nitric oxide, carbon dioxide. These differences are related to the adsorbability of the gases.—A. L. M. **Sowerby** and S. **Barratt**: The line absorption spectra of the alkali metals. The alkali metals are all able to absorb the lines of the combination series *1s-md*, contrary to the Selection Principle. The cæsium series of this type has been observed for the first time. The absorption of this series by potassium is uninfluenced by the presence of argon at two atmospheres pressure. It is estimated that 12,000 times as many atoms can absorb the first member of the principal series of potassium and rubidium as can absorb the line *1s-3d*, the ratio being the same for the two metals. The "atomic extinction coefficients" of the different alkali metals are approximately the same for corresponding lines.—A. M. **Tyndall** and G. C. **Grindley**: The mobility of ions in air. Pts. i. and ii. The improved method of measuring mobility depends on producing ions by flashes of α-rays subjected to a special alternating field. The effect of water vapour is to cause fall of mobility of fully formed negative ions down to a value 1·6 in saturated air. Positive ions of two types were found—initial and final. The mobility of the initial type is indistinguishable from that of the negative and is similarly affected by water vapour. Water vapour has a retarding influence on rate of transformation into final ions. In ordinary dry air much transformation occurs within 0·007 sec. of birth, but in wet air the ions nearly all remain in the initial stage at double this age.—W. **Jevons**: A band spectrum of tin monochloride exhibiting isotope effects. The spectrum of the uncondensed discharge through $SnCl_4$ vapour comprises a continuous spectrum between λ 4900 and λ 3950, and a hitherto unrecorded band spectrum consisting of two distinct sets of bands occupying the regions λ 3910 – λ 3486 and λ 3405 – λ 2830 respectively. Each set is attributed to a chloride of tin. The bands in the more refrangible set constitute two systems α and β of the normal Deslandres type. If they be ascribed to $SnCl^{35}$, a few additional bands in the same region are attributable to $SnCl^{37}$. There is also some indication of the tin isotope effect. The less refrangible set consists of several groups, each containing a few close bands degraded towards the red. Too little is known of these bands to say whether they are emitted by SnCl or by a polyatomic chloride.—J. H. **Andrew**, M. S. **Fisher** and J. M. **Robertson**: Some physical properties of steel and their determination. Methods of measuring electrical resistance, electrode potential, and continuous change of resistance during tempering, are described. The change from martensite to granular pearlite is gradual and only proceeds to a certain stage at each temperature. Martensite is not formed during tempering at constant temperature, but results from the decomposition of austenite during cooling from the tempering temperature. The rate of tempering of martensite is not affected by the addition of moderate amounts of special elements. Austenite tempers more slowly, and its rate of tempering is considerably reduced by addition of special elements.—N. K. **Adam** and G. **Jessop**: Note on the spreading of solids on water surfaces. Cary and Rideal's observations on the spreading of myristic acid on water have been continued down to very low compressions. A small pressure, that of the "gaseous" state of the film, is set up immediately the crystal touches the surface, and the "two-dimensional vapour pressure" very soon afterwards.

Royal Microscopical Society, December 16.—F. I. G. **Rawlins**: The theory of dimensions in microscopy. The fundamental quantities of interest to the microscopist, such as the power of a lens, curvature, numerical aperture, resolution, convergence, are considered from a dimensional point of view. A number of magnitudes in common use for interference work are discussed dimensionally, and the importance of the inclusion of the appropriate constants of proportionality when dealing with geometrical properties is stressed.

Edinburgh.

Royal Society, January 11.—A. Anstruther **Lawson**: The origin of endemism. The vast continental, insular flora of Australia, with 70 per cent. of its species and 30 per cent. of its genera endemic, is perhaps the most favourable of all fields for the study of endemism. From a study of their habits, habitat, foliage, variability, great profusion of flowers, sterility of flowers, and low percentage of seed set of the main endemic types, which is so characteristic, it seems at least the majority are hybrids Hybridisation seems to occur in the Australian flora wherever possible, and the possibilities are quite general. The endemic flora had its origin as hybrid mutations derived in the first place from non-endemic types. Hybrid mutations—followed by natural selection—has been the main determining factor and influence in the evolution of the Australian flora. Such conclusions are directly opposed to the theory of De Vries and to the Morgan School in America.—G. Gordon **Harrower**: A study of Ho-kien and Tamil skulls. The Ho-kien, native of the Chinese province of Foo-kien, differs in certain particulars from that of the northern Chinese, and represents a more or less pure strain of the indigenous Mongolian type which preceded the Chinese in south-eastern Asia. Comparisons reveal certain affinities with one type of Tibetan skull—a point of interest in connexion with the question of origins. The sample of Tamil skulls collected represents one group of the indigenous Dravidians of southern India. The skull is relatively long and narrow, and is high; the face is low and relatively broad, and the nasal aperture is only moderately broad in proportion to the height. The skull differs in several particulars from European skulls of the same class, notably in the smaller expansion of the occiput; it shows no admixture with the intrusive Aryan element.—D. A. **Fairweather**: Electrosynthesis in the series of normal dibasic acids. Three new acids of this series have been synthesised by Crum Brown and Walker's electrosynthetic method, namely, those with 20, 24 and 28 methylene groups.—C. C. **Miller**: The slow oxidation of phosphorus trioxide Pt. i. The action of water vapour on phosphorus trioxide. The oxidation of phosphorus trioxide to pentoxide by oxygen at low temperatures (25°) is accompanied by luminescence, and only takes place in the presence of water vapour, the pressure of which need only be very low. In the absence of oxygen it was found that at 25°, under certain conditions, comparatively large quantities of gaseous and liquid phosphuretted hydrogen were produced, which may play a part in the oxidation when oxygen is present.—E. T. **Copson**: Partial differential equations and the calculus of variations. The conditions under which a linear partial differential quation of the second order may be derived by nnulling the variation of an integral are determined. The self-adjoint equation is shown to be a particular case. Systems of equations are also discussed.

Rome.

Royal Academy of the Lincei, November 15.—T. **evi-Civita**: Gravitational movements in one dimension.—G. **Armellini**: Theory of the flying shadows in solar eclipses. The shadow bands moving in front of, and parallel to, the lunar shadow during total solar eclipses are regarded as an ordinary diffraction phenomenon.—F. **Zambonini** and G. **Carobbi**: Double sulphates of rare earth and alkali metals (iv.). Double sulphates of neodymium and sodium. Compounds containing $Nd_2(SO_4)_3$, Na_2SO_4, and H_2O in the respective molecular proportions 1:1:2, 4:5:8, 3:4:6, and 2:3:5 have been obtained as pale violet-red crystals.—F. **Zambonini** and R. G. **Levi**: Isomorphism of molybdates of the rare earth metals with those of calcium, strontium, barium, and lead (iv.). Structure of the molybdates of lanthanum, cerium, praseodymium, neodymium, and samarium.—L. **Sabbatani**: Pharmacological action of iron with double and complex salts.—S. **Franchi**: Geological problems in the Franco-Italian Alps.—L. A. **Herrera**: Imitation of cell-division and spore-germination by means of calcium fluosilicate.—G. **Tizzoni**, E. **Centanni**, and G. **De Angelis**: Modifications produced by radium in the substance of the cancer tumour of the young rat, and its transformation into a curative vaccine.—W. **Blaschke**: Cyclic systems of curves on a surface.—Antonio **Signorini**: A theorem of existence and singularity in the statics of materials exhibiting low resistance to tension.—Bruno **Finzi**: Potential laminary liquid motions on developable surfaces.—Rita **Brunetti**: Relative magnitude of atoms and ions.—A. **Pontremoli**: A characteristic experiment in electric or magnetic double refraction.—G. R. **Levi**: The varieties of thorium oxide and their catalytic action in the dehydration of alcohol. The so-called meta-oxide of thorium is crystalline and identical with the normal oxide, whereas the thorium hydroxide usually obtained is amorphous and undergoes transformation into an amorphous oxide stable at temperatures higher than 300°. The catalytic influence of the oxide on the dehydration of alcohol is not affected by its crystalline or amorphous character.—Raoul **Poggi**: Some derivatives of toluene.—C. **Sandonnini**: Actions in the presence of carbon.—Paolo **Principi**: Observations on the geology of the upper and middle valleys of Savio.—Beatrice **Torelli**: The significance of heterochromosomes.—Umberto **D'Ancona**: Influence of salt solutions on the resistance of young eels to fasting.—Remo **Grandori**: Studies on the blastokinesis of insects.

Washington, D.C.

National Academy of Sciences (*Proc.*, Vol. 11, No. 12, December 1925).—George H. **Shull**: The third linkage group in Œnothera. A mutation called "old-gold" (*vetaurea*) found in *Œ. Lamarckiana* is the first discovered factor of a third linkage group. Another factor of the same group, "double" flowers (called mutant *supplena*), is now announced.—Horace W. **Feldman**: Fertility of the rat, *Mus norvegicus*. Fertility in the Norway rat is generally dependent on the vigour of the female. The size of litter increases to a maximum at the age of 150-179 days and decreases afterwards to a minimum, due apparently to the decrease of general vigour with age. Inbreeding increased the frequency of still-births. Seasonal fluctuations occurred: litters showed an average maximum (7·3 young) in June, decreasing to a low point (5·2 young) in October and increasing again in November and December.—Tracy Yerkes **Thomas**: Invariants of relative quadratic differential forms.—R. L. **Wilder**: A property which characterises continuous curves. A continuous curve is a bounded continuum connected *im kleinen*, and such curves are characterised by being "normally connected."—Carl **Barus**: Telephonic coupling of acoustic and electrical oscillations evidenced by the pinhole probe.—J. C. **Slater**: Interpretation of the hydrogen and helium spectra. Pauli has suggested that the double levels in atoms having one valence electron have some connexion with a duality in the quantum laws. This would lead to resemblances between the spectra of hydrogen and helium and those of the alkalis and alkaline earths respectively. Evidence of this is adduced.—J. G. **Winans**: Radiation emitted by optically excited zinc vapour. Zinc vapour in a quartz "resonance" tube was illuminated by a water-cooled zinc arc maintained in a quartz tube. Thirteen lines were detected in the spectrum observed and accounted for; in addition, four bands appear which are more intense relative to the lines in the optically excited radiation than in that from the zinc arc. Mercury as an impurity in the zinc vapour gives evidence of "impact fluorescence."—Ernest Merritt: On contact rectification by metallic germanium. Rectifying properties were observed, the contact being stable, and the behaviour at different points fairly uniform. Making contact with bismuth gives anomalous results. Platinum was also used and the temperature raised. The resistance of the contact becomes much smaller, and at 220° C. it was the same in both directions through the contact. On cooling, the resistance remained greater than it was before heating, due apparently to a highly resistant film of oxide.—Henry Fairfield Osborn: The origin of species (ii.). Further detailed statements are made on some of the nine bio-mechanical principles of adaptation enunciated in an earlier paper (NATURE, June 13, 1925, p. 925, and June 20, 1925, p. 961).—Raymond Pearl: Vital statistics of the National Academy of Sciences. (i.) Age at election. The original membership was of high average age; of the 48 charter members, only 4 were less than 38 years old. During the period 1864–83, the mean age at election was 44·47 years; for 1884–1904, it increased to 46·54 years; and for 1905–1924, another four years were added. Of the 213 elected during this last period, only 8 were less than 38 years old. These figures show the same tendency as the statistics of the Royal Society. (ii.) Elections of young men. 43 persons, including 2 charter members, were less than 37 years old at election. Of these, 30 worked at the physical and 12 at the biological sciences. The youngest man elected was the astronomer, E. C. Pickering (26·8 years), and the next youngest, the engineer, Fairman Roger, charter member (29·3 years). (iii.) Mortality. At 40 years of age, members of the Academy have a mean after lifetime more than five years greater than that of urban white males of the United States, and some increased expectation is maintained up to the age of 85 years. This might be expected, since they belong to the occupational groups giving superior risks from the life insurance viewpoint. (iv.) The present limitation to total membership and other matters. With living membership of 221, 15 elections, and an average of 8 deaths annually, the Academy will reach its limit of 250 members in 1929; thereafter, the mortality will allow of the election of 6 to 8 members a year. The present mean age of members is 60·74±0·47 years; their mean duration of service is 12·17±0·48 years, and that of members who have died was 19·57±0·60 years.—Marston Taylor Bogert and Hugh Blake Corbitt: Researches on thiazoles (x). The synthesis of some 2-phenyl-benzothiazole arsonic acids. These compounds are important therapeutically, for one of them has a greater action on *Tr. equiperdum* and greater toxicity for white rats than the corresponding benzene compound, but there was no evidence of any effect on the nervous system such as is frequently caused by penta-valent arsenic compounds.—S. C. Lind: The origin of terrestrial helium and its association with other gases. Helium is very generally distributed in natural gases, but in widely different concentrations (maximum nearly 4 per cent.). It is not confined to limited geological horizons, suggesting that its occurrence in quantity is due to prevention of leakage by a gas-seal, such as a capping of shale containing clay. A radioactive origin is favoured. It is always found with high though variable nitrogen content, possibly due to the action of the initial α-particle producing nitrogen and helium simultaneously, from some nitrogen compound in the parent mineral.

Official Publications Received.

The Kent Incorporated Society for Promoting Experiments in Horticulture. Annual Report, East Malling Research Station, 1st January 1924 to 31st December 1924. Pp. 216. (East Malling.) 5s.

Egyptian Government: Anti-Malaria Commission. The Mosquitoes of Egypt. By T. W. Kirkpatrick. Pp. xii+224+24 plates+2 maps. (Cairo: Government Publications Office.) 30 P.T.

Union of South Africa: Department of Agriculture. Science Bulletin No. 38: Report on the Cost of Production of Maize Investigation for the Season 1922–23. By E. Parrish. Pp. 30. 3d. Science Bulletin No. 41: Note on the Storage of Eggs. By H. A. Griffiths, D. J. R. de Villiers and Leitch Anderson. Pp. 16. 3d. Science Bulletin No. 42: (i) Further Investigations into the Causes producing Rosette of Apricot and Plum Trees in the Wellington District; (ii) Report on some Preliminary Investigations into the Influence of Alkali Soils on Peach Stocks employed for Apricot and Plum Trees. By Dr. R. Marloth. Pp. 30. 3d. (Pretoria: Government Printing and Stationery Office.)

Department of Commerce: Bureau of Standards. Circular of the Bureau of Standards, No. 1: National Bureau of Standards; its Functions and Activities. Second edition. Pp. vi+118. (Washington: Government Printing Office.) 30 cents.

Proceedings of the Society for Psychical Research. Part 96, Vol. 35, December. Pp. 471-594. (London: Francis Edwards.) 7s. net.

South Australia. Annual Report of the Director of Mines and Government Geologist for 1924. Pp. 8. (Adelaide: R. E. E. Rogers.)

University of Illinois Engineering Experiment Station. Bulletin No. 151: A Study of Skip Hoisting at Illinois Coal Mines. By Prof. Arthur J. Hoskin. Pp. 66. (Urbana, Ill.) 35 cents.

Madras Agricultural Department. Year Book, 1924. Pp. 94. (Madras: Government Press.) 14 annas.

Report on the Operations of the Department of Agriculture, Madras Presidency, for the Year 1924–25. Pp. 51+5. (Madras: Government Press.) 4 annas.

Agricultural Research Institute, Pusa. Bulletin No. 161: List of Publications on Indian Entomology, 1924. (Compiled by the Imperial Entomologist.) Pp. ii+41. 8 annas; 9d. Bulletin No. 163: Loss of Sugar by Inversion in Sugar Factories in Northern India and its Prevention by Antiseptic Measures. By C. M. Hutchinson and C. S. Ramayyar. Pp. ii+9. 2 annas; 3d. (Calcutta: Government of India Central Publication Branch.)

Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau central de Magnétisme terrestre. Publiées par les soins de Prof. Ch. Maurain. Tome 3. Pp. viii+165. (Paris: Les Presses universitaires de France.)

Société des Nations: Organisation d'hygiène sous-comité du Cancer. (League of Nations: Health Organisation Sub-Committee on Cancer.) Rapport sur les résultats des enquêtes démographiques dans certains pays. (Report on the Results of Demographic Investigations in certain selected Countries). C.H. 333, Vol. 1. Pp. 168. Rapport sur les résultats de certaines enquêtes cliniques se rapportant aux différences de mortalité cancéreuse dans certains pays choisis spécialement. (Report on the Results of certain Clinical Enquiries relating to Differences of Cancer Mortality in certain selected Countries.) C.H. 333, Vol. 2. Pp. 30. (Genève: Société des Nations; London: Constable and Co., Ltd.)

The Observer's Handbook for 1926. Edited by C. A. Chant (Eighteenth Year of Publication.) Pp. 72. (Toronto: Royal Astronomical Society of Canada.)

Ministry of Public Works, Egypt: Physical Department. An Experiment to Determine Corrections to Sounding in River Gauging. B Dr. P. Phillips. (Physical Department Paper No. 18.) Pp. 26+2 plates. (Cairo: Government Publications Office.) 5 P.T.

University of Adelaide. Publications under the Keith Sherida Foundation, No. 1: Dentition and Palate of the Australian Aboriginal By Dr. T. D. Campbell. (Thesis presented for the Degree of Doctor o Dental Science.) Pp. viii+123+63 plates. (Adelaide.)

The Marine Biological Station at Port Erin (Isle of Man). being th Thirty-ninth Annual Report of the former Liverpool Marine Biolog Committee, now the Oceanography Department of the University Liverpool. Drawn up by Prof. Jas. Johnstone. Pp. 40. (Liverpool University Press of Liverpool, Ltd.; London: Hodder and Stoughto Ltd.) 1s. 6d. net.

The Manchester Museum. Notes from the Manchester Museum, N 28: Some Collembola from Southern New Zealand. By Dr. George J Carpenter. (Museum Publication 89.) Pp. 16. 2s. Report of th Museum Committee for the Year 1924–25. (Museum Publication 90 Pp. 19. 6d. net. Notes from the Manchester Museum, No. 29: T Distribution of Margaritana Margaritifera in the British Islands. P J. Wilfrid Jackson. (Museum Publication 91.) Pp. 10. 1s. 6 (Manchester.)

National Museum of Wales. Guide to the Collections of British Lepidoptera. Pp. 81+2 plates. (Cardiff.) 6d.

Canterbury College (University of New Zealand). Records of t Canterbury Museum. Vol. 2, No. 5. Pp. 269-330+plates 41- (Christchurch, N.Z.)

Appendix No. 2 to the Annual Report of the Chief of the Bureau Navigation, 1925. Annual Report of the Naval Observatory for t Fiscal Year 1925. Pp. 21. (Washington: Government Printing Office.

Annuaire pour l'an 1926 publié par le Bureau des Longitudes. Pp. viii+665+A128+B121+C68. (Paris: Gauthier-Villars et Cie.) 8 francs.

The Indian Forest Records. (Entomology Series), Vol. 12, Part 2: Identification of Immature Stages of Indian Cerambycidae I. Cerambycinae. By J. C. M. Gardner. Pp. 17+8 plates. (Calcutta: Government of India Central Publication Branch.) 8 annas; 9d.

Field Museum of Natural History. Zoological Series, Vol. 13: Catalogue of Birds of the Americas and the adjacent Islands in Field Museum of Natural History; including all Species and Subspecies known to occur in North America, Mexico, Central America, South America, the West Indies and Islands of the Caribbean Sea, the Galapagos Archipelago, and other Islands which may be included on account of their Faunal Affinities. Initiated by Charles B. Cory; continued by Charles E. Hellmayr. Part 4: Furnariidae—Dendrocolaptidae. (Publication 234.) Pp. iv+390. (Chicago.)

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 14, No. 1: A Study of some Indian Grasses and Grasslands. By Dr. W. Burns, L. B. Kulkarni and S. R. Godbole. Pp. v+57+4 plates. (Calcutta: Government of India Central Publication Branch.) 12 annas; 1s. 3d.

Air Ministry: Meteorological Office. International Meteorological Organization: Commission for the Exploration of the Upper Air. Report of the Meeting in London, April 16-22, 1925. (M.O. 281.) Pp. 79+2 plates. (London: H.M. Stationery Office.) 3s. net.

Proceedings of the Royal Society of Edinburgh, Session 1925-1926. Vol. 46, Part 1, No. 3: The Diffusion of Salt Vapours in a Bunsen Flame. By Fred. J. Symon. Pp. 15-19. 6d. Vol. 46, Part 1, No 4: Researches into the Characteristic Numbers of the Mathieu Equation. By Dr. E. L. Ince. Pp. 20-29. 1s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Union of South Africa. Journal of the Department of Agriculture. Vol. 11, No. 6, December: The Annual Report of the Department of Agriculture for the Year ended 30th June 1925. Pp. xxxvi+469-536. (Pretoria: Government Printing and Stationery Office.) 6d.

South Australia: Department of Mines. Mining Review for the Half-year ended June 30th, 1925. (No. 42.) Pp. 89+5 plates. (Adelaide: R. E. E. Rogers.)

Scientific Papers of the Institute of Physical and Chemical Research. Vol. 1, No. 1: Band Spectra of Mercury. By Hantaro Nagaoka. Pp. [illegible]+1 plate. n.p. Vol. 1, No. 2: On the Chemical Constituents of Squalene. By Riko Majima and Bennosuké Kubota. Pp. 7-21. 30 sen. Vol. 1, No. 3: On the Nature of Graphite and Amorphous Carbon. By Genshichi Asahara. Pp. 23-30+1 plate. 30 sen. Vol. 1, No. 4: A Study on the Reducing Action of Ferrous Hydroxide. By Susumu Miyamoto. Pp. 31-56. 25 sen. Vol. 1, No. 5 On the Detection and Separation of Indium. By Isaburo Wada and Sunao Ato. Pp. 57-77. 35 sen. Vol. 1, No. 6-7: Absorption of Moisture by Fibrous Insulating Materials, by Tsunetaro Kujirai, Yôsô Kobayashi and Yotsuo Toriyama; Effect of Humidity on the Electrical Resistance of Fibrous Insulating Materials, by Tsunetaro Kujirai and Takeo Akahira. Pp. 79-124. 65 sen. Vol. 1, No. 8: The Band Spectra and the Electronic Configuration of Nitrogen and Carbon Monoxide Molecules. By Hantaro Nagaoka. Pp. 125-134. [illegible]0 sen. Vol. 1, No. 9: On a Microbarograph. By Hantaro Nagaoka and Naoshi Ayaba. Pp. 135-138+2 plates. 25 sen. Vol. 1, No. 10: On a new Method of Separation of Iridium from Rhodium and Platinum, and the Separation of Platinum and Rhodium. By Isaburo Wada and Tamaki Nakazono. Pp. 139-154. 25 sen. Vol. 1, No. 11: On the Regularity in the Distribution of Spectral Lines of Iron and Intra-atomic Magnetic Field. By Hantaro Nagaoka and Yoshikatsu Sugiura. Pp. 155-206. 35 sen. (Komagome, Hongo.)

Report on Norwegian Fishery and Marine Investigations. Vol. 3, No. 4: Frequency Curves in Herring Investigation. By Einar Lea. Pp. 27. Vol. 3, No. 6: On the Growth of the Cod and the Formation of Annual Zones in the Scales. By Alf Dannevig. Pp. 24+12 plates. (Bergen: A.S. John Griegs Boktrykkeri.)

British Museum (Natural History). Coloured Postcards. Set E29, Exotic Butterflies, Series No. 4. 5 cards in colour, 1s. Set E30, Exotic Butterflies, Series No. 5. 5 cards in colour, 1s. Set E31, Exotic Moths, Series No. 7. 5 cards in colour, 1s. Set E32, Exotic Moths, Series No. [illegible]. 5 cards in colour, 1s. Set E33, Exotic Beetles, Series No. 2. 5 cards in colour, 1s. Set E34, Exotic Beetles, Series No. 3. 5 cards in colour, 1s. Set E35, Exotic Homoptera, Series No. 3 (Bugs). 5 cards in colour, 1s. Set E36, Exotic Heteroptera, Series No. 1 (Bugs). 5 cards in colour, 1s. Set E37, Exotic Orthoptera, Series No. 2 (Cockroaches, Stick-insects and Grasshoppers). 5 cards in colour, 1s. Set E38, Exotic Orthoptera, Series No. 3 (Grasshoppers) 5 cards in colour, 1s. (London: British Museum (Natural History).)

Bulletin of the American Museum of Natural History. Vol. 52, Art. [illegible]: The Gulls (Laridae) of the World; their Plumages, Moults, Variations, Relationships and Distribution. By Dr. Jonathan Dwight. Pp. 8-401+plates 11-15. (New York.)

Bulletin of the University of Wisconsin. Serial No. 1370, General Series No. 1048: Phytoplankton of the Inland Lakes of Wisconsin. Part 2: Desmidiaceae. By Gilbert Morgan Smith. (Wisconsin Geological and Natural History Survey, Bulletin 57, Part 2.) Pp. ii+227. (Madison.)

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures and Condition of the Institution for the Year ending June 30, 1924. (Publication 2795.) Pp. xii+563+103 plates. (Washington: Government Printing Office.) 1.75 dollars.

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 25: Flora of Utah and Nevada. By Ivar Tidestrom. Pp. 665+15 plates. (Washington: Government Printing Office.) 80 cents.

Smithsonian Institution: United States National Museum. Bulletin [illegible]0, Vol. 2, Part 4: Contributions to the Biology of the Philippine Archipelago and adjacent Regions. Siliceous and Horny Sponges collected by the U.S. Fisheries Steamer *Albatross* during the Philippine Expedition, 1907-10. By Prof. H. V. Wilson. Pp. vii+273-532+plates [illegible]-52. (Washington: Government Printing Office.) 85 cents.

Department of the Interior: U.S. Geological Survey. Bulletin 771: Ore Deposits of the Saddle Mountain and Banner Mining Districts, Arizona. By Clyde P. Ross. Pp. vii+72+17 plates. 25 cents. Bulletin 773: Mineral Resources of Alaska; Report on Progress of Investigations in 1923. By A. H. Brooks and others. Pp. iii+267+xv+6 plates. 40 cents. Bulletin 774: The Copper Deposits near Salmon, Idaho. By Clyde P. Ross. Pp. iv+44+5 plates. 15 cents. (Washington: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 547: Surface Water Supply of the United States, 1922. Part 7: Lower Mississippi River Basin. Pp. iv+106+2 plates. 15 cents. Water-Supply Paper 560-D: Preliminary Report on the Geology and Water Resources of the Mud Lake Basin, Idaho. By H. T. Stearns and L. L. Bryan. Pp. iv+87-134+2 plates. n.p. (Washington: Government Printing Office.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des réunions. Vol. 33: Procès-verbaux (Septembre 1925). Pp. 92. Publications de Circonstance, No. 89: The Herrings along the Baltic Coast of Sweden. By Chr. Hessle. Pp. 54+8 maps. (Copenhague: Andr. Fred. Høst et fils.)

Committee of the Privy Council for Medical Research. Report of the Medical Research Council for the Year 1924-25. Pp. 164. (London: H.M. Stationery Office.) 3s. 6d. net.

Jamaica. Annual Report of the Department of Science and Agriculture for the Year ended 31st December 1924. Pp. 42. (Jamaica: Government Printing Office, Kingston.)

University of Illinois Engineering Experiment Station. Bulletin No. 152: An Investigation of the Fatigue of Metals, Series of 1925; a Report of the Investigation conducted by the Engineering Experiment Station, University of Illinois, in cooperation with the National Research Council, the Engineering Foundation, the General Electric Company, the Allis-Chalmers Manufacturing Company, the Copper and Brass Research Association, the Western Electric Company. By Prof. H. F. Moore and Prof. T. M. Jasper. Pp. 92. (Urbana, Ill.) 50 cents.

Veroffentlichungen des Geobotanischen Institutes Rubel in Zurich, Heft 3. Festschrift Carl Schröter. Gewidmet von seinen Freunden, Schulern und Kollegen. Im Auftrag des Schroter-Jubilaum-Komitee redigiert von H. Brockmann-Jerosch. Pp. viii+811+28 Tafeln. (Zurich: Rascher und Co.) 30 francs.

Maps showing the Mean Atmospheric Pressure and Wind Direction and Force over the China Sea for each Month of the Year. (Published under the Authority of H.E. the Governor of Hongkong.) Pp. ii+12 maps. (Hongkong: Royal Observatory.) 3 dollars.

Report on the Health of the Army for the Year 1923. (Vol. 59.) Pp. iv+156. (London: H.M. Stationery Office.) 3s. 6d. net

Report of the Danish Biological Station to the Board of Agriculture. No. 30, 1924: Studies on the Biology of the Oyster (*Ostrea edulis*) in the Limfjord, with Special Reference to the Influence of Temperature on the Sex Change. By R. Sparck. Pp. 84. (Copenhagen: G. E. C. Gad.)

Proceedings of the Royal Society of Edinburgh, Session 1924-1925. Vol. 45, Part 4, No. 29: The Precipitation of Sols by Polyvalent Ions. By Dr. W. W. Taylor. Pp. 323-333. 1s. Vol. 45, Part 4, No. 30 Salmon (*Salmo salar*) of the River Moisie (Eastern Canada). By W. J. M. Menzies. Pp. 334-345. 1s. 6d. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Imperial College of Tropical Agriculture. Prospectus for the Year 1926-27; Principal's Report and Register. Pp. 25. (Trinidad; London: 14 Trinity Square, E.C.3.)

Proceedings of the Royal Irish Academy. Vol. 37, Section B, No. 9: The Estimation of Aldehyde in Alcoholic Liquors by Means of Schiff's Reagent. By Dr. Kenneth C. Bailey. Pp. 58-70. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6d.

Department of Scientific and Industrial Research. Report of the Food Investigation Board for the Year 1924. Pp. vi+80+6 plates. (London: H.M. Stationery Office.) 3s. 6d. net.

Carnegie Institution of Washington. Year Book No 24, July 1, 1924, to June 30, 1925; with Administrative Reports through December 11, 1925. Pp. xix+46+392. (Washington.)

Věstník Královské České Společnosti Nauk: Třída matematicko-přírodovědecká. (Mémoires de la Société royale des Sciences de Bohême: Classe des Sciences.) Ročník 1924 (Année 1924). Pp. ii+525. (Praze (Prague): Františka Řivnáče.)

Diary of Societies.

SATURDAY, JANUARY 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—H. Balfour: The British Coracle or Skin-covered Boat, and its Affinities.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—P. F. Hope: The Sinking of Monkton Shaft.

INSTITUTE OF METALS (North-East Coast Local Section) (jointly with Institution of British Foundrymen) (at Neville Hall, Newcastle-upon-Tyne), at 6.15.

MONDAY, FEBRUARY 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Edmunds: Pseudo-Hermaphroditism and Hypospadias and their Surgical Treatment.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—G. O. Case: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 6.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—G. C. Field: Ancient Philosophy and Modern Science.

ROYAL SOCIETY OF ARTS, at 8.—H. P. Shapland: The Decoration of Furniture (Cantor Lecture) (3).

Society of Chemical Industry (London Section) (at Institution of Mechanical Engineers), at 8.—F. H. Carr: The Training of Chemists for Industry.

Royal Institute of British Architects, at 8.30.—Presidential Address to Students.

Royal Society of Medicine (Social Evening), at 9.30.—Dr. F. J. Poynton: The Part taken by Doctors in the Early Days of Aeronautics.

TUESDAY, February 2.

Imperial College Chemical Society (jointly with Royal College of Science Natural History Society and Royal College of Science Physical and Mathematical Society), at 5.—Prof. H. E. Armstrong: Chemical Change in General.

Royal Institution of Great Britain, at 5.15.—Dr. E. K. Rideal: Surface Action (1).

Manchester Geological and Mining Society (at the University, Manchester), at 6.—Sir Stopford Brunton: Mining in Canada with regard to Migration.

Institute of Marine Engineers, at 6.30.—S. S. Cook: High-efficiency Steam Installations for Ship Propulsion.

Institution of Electrical Engineers (North-Western Centre) (at Engineers' Club, Manchester), at 7.—E. V. Clarke: Power Factor and Tariff.

Royal Photographic Society of Great Britain (Pictorial Group), at 7.

Institution of Automobile Engineers (Coventry Graduates' Section) (at Broadgate Café, Coventry), at 7.15.—J. R. Harriott: Developments in Motor Cycle Design.

North-East Coast Institution of Engineers and Shipbuilders (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—Capt. Rogers: Ships' Cargo Handling Appliances.

Röntgen Society (at British Institute of Radiology), at 8.15.—R. J. McCallum Tozer: A Gas Tube with Variable Penetrating Power.—M. A. Codd: A New Regulator for a Gas Tube.

Society of Chemical Industry (South Wales Section) (at Institute of Engineers, Cardiff).—W. J. U. Woolcock: Medicinal Fine Chemicals.

WEDNESDAY, February 3.

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. Ridley and others: Discussion on Power Production and Transmission.

Royal College of Surgeons of England, at 5.—Prof. J. E. Adams: The Surgery of the Jejunum.

Geological Society of London, at 5.30.—Prof. S. J. Shand: The Alkaline Rocks and Ring-Intrusions of Pilansberg (Transvaal) (Lecture).

Institution of Electrical Engineers (Wireless Section), at 6.—J. Hollingworth: The Propagation of Electric Waves.

Society of Public Analysts and other Analytical Chemists (Annual General Meeting) (at Chemical Society), at 8.—Dr. L. H. Lampitt and E. B. Hughes: The Determination of Copper in Vegetables.—Dr. H. E. Cox: Arsenic in Apples.—A. J. Berry:—The Titration of Thallous Salts by Potassium Iodate.—C. H. Wright: The Hot Springs at Nasavusavu.

Royal Society of Arts, at 8.—Sir John Russell: Investigations in Agricultural Science at Rothamsted.

Entomological Society of London, at 8.—G. Fox-Wilson: The Insect Visitors to Slime-Flux.

THURSDAY, February 4.

Royal Society, at 4.30.—Prof. W. A. Bone and R. Quarendon: Researches on the Chemistry of Coal. Part IV.—G. M. B. Dobson and D. N. Harrison: Measurements of the Amount of Ozone in the Earth's Atmosphere and its Relation to other Geophysical Conditions.—Dr. C. Chree: Atmospheric Ozone and Terrestrial Magnetism.—Dr. J. S. Owens: Condensation of Water from the Air upon Hygroscopic Crystals.—*To be read in title only*:—Prof. T. H. Havelock: Wave Resistance: Some Cases of Unsymmetrical Forms.—Dr. H. Jeffreys: On the Formation of Water Waves by Wind.—Prof. G. T. Morgan, W. J. Hickinbottom, and T. V. Barker: Stereoisomeric Diaryl-$\beta\gamma$-Diamino-N-Butanes.—Prof. G. T. Morgan and G. R. Davies: Antimonial Analogues of the Cacodyl Series.—Prof. G. T. Morgan and V. E. Yarsley: Dimethylstibine Cyanide, an Analogue of Cacodyl Cyanide.

Linnean Society of London, at 5.—C. C. A. Monro: Polychæta of the *Alert* Expedition;—Conclusion.—Dr. C. C. Hurst: On the Nature and Origin of Species in Rosa.

Royal Institution of Great Britain, at 5.15.—Dr. J. L. Myres: Who were the Greeks? (1).

Institution of Electrical Engineers, at 6.—E. V. Clark: Power Factor and Tariff.—H. W. Dorey: Power Factor Improvement.

Institution of Automobile Engineers (at Royal Society of Arts), at 7.—C. L. Lawrence: American Aeronautical Engine Practice.

Society of Chemical Industry (Bristol Section) (at Bristol University), at 7.30.—Dr. A. Parker: The Smokeless Fuel Problem.

Institution of Structural Engineers, at 7.30.—W. J. H. Leverton: The Æsthetic Treatment of Concrete.

Chemical Society, at 8.—F. G. Mann and Sir William J. Pope: (*a*) The Complex Salts of $\beta\beta'\beta''$-triaminotriethylamine with Nickel and Palladium; (*b*) $\gamma\gamma'\gamma''$-Triaminotripropylamine and its Complex Compounds with Nickel.—P. L. Robinson and H. C. Smith: A Comparison of the Atomic Weight of Silicon from Different Sources.

Institution of Mechanical Engineers (Glasgow Branch) (at Glasgow), T. B. Mackenzie: Modern Steel Works Plant for Boiler and Ship Plates Manufacture.

FRIDAY, February 5.

Royal Sanitary Institute (at Town Hall, Bradford), at 2.—Dr. J. R. Kaye, Dr. Helen M. Gall, Dr. Charlotte A. Douglas, Katherine Gamgee, and others: Discussion on Child Welfare Centres and their Adjuncts.—At 5.—F. Marsden, F. White, and others: Discussion on Town Planning and Improvement Areas.

Royal Astronomical Society (Geophysical Discussion), at 5.—R. D. Oldham and Prof. Turner: The Depths of Earthquake Foci in Relation to Distribution of Intensity on the Surface. Sir Gilbert Walker in the chair.

Royal College of Surgeons of England, at 5.—Prof. M. Woodman: Malignant Disease of the Œsophagus.

Society of Chemical Industry (Manchester Section) (at 16 St. Mary's Parsonage, Manchester), at 7.—A. Beavell: Fluid Heat Transmission for High Temperatures in Industrial Processes.

Royal Photographic Society of Great Britain, at 7.—S. L. Bevestaff: Thoughts which occur to me.

Photomicrographic Society (at 4 Fetter Lane), at 7.—F. A. Buddock: Photomicrography applied to Metallurgy.

Society of Chemical Industry (South Wales Section) (at Swansea Technical College), at 7.30.—C. A. Seyler: Micro-structure of Coal.

Junior Institution of Engineers, at 7.30.—Question and Discussion Evening.

North-East Coast Institution of Engineers and Shipbuilders (Middlesbrough Branch, Graduate Section) (at Middlesbrough), at 7.30.—E. Clarke: Launching.

Geologists' Association (at University College) (Annual General Meeting), at 8.—H. Dewey: Studies in Danish Geology (Presidential Address).

Royal Institution of Great Britain, at 9.—Prof. G. Gordon: Shakespeare's English.

SATURDAY, February 6.

Association of Women Science Teachers (Annual General Meeting) (at St. Paul's Girls' School), at 10.30 A.M.—Educational Films, chiefly Scientific, shown by the Visual Education Society.—At 2.30.—Miss Coward: The Teaching of Hygiene in Schools; Short Papers on the same subject.

Society of Chemical Industry (South Wales Section) (jointly with Institute of Chemistry and Wales and Monmouthshire Junior Gas Association) (at University College, Singleton Park, Swansea), at 2.30.—C. A. Seyler: The Microscopy of Coal.

Royal Institution of Great Britain, at 3.—Sir Walford Davies: The Triad and the Perfect Fourth (1).

Gilbert White Fellowship (at 6 Queen Square, W.C.1), at 3.—Miss L. E. Cheesman: Insect Collecting in the Society Islands.

PUBLIC LECTURES.

SATURDAY, January 30.

Horniman Museum (Forest Hill), at 3.30.—H. Harcourt: Glimpses of Indian Places and Peoples.

MONDAY, February 1.

University College, at 4.—Prof. A. V. Hill: The Physiology of Muscle. (Succeeding Lectures on February 8, 15, 22, March 1, 8.)—At 5.15.—Dr. R. W. Lunt: The Chemistry of Ionisation by Collision (Succeeding Lectures on February 8, 15, 22, March 1, 8.)—At 5.30.—Dr. A. S. Parkes: The Physiology of Reproduction. (Succeeding Lectures on February 8, 15, 22.)—At 5.30.—Prof. E. De Martonne Two French Geographical Regions: (1) Brittany; (2) The "Causses" of Southern France. (Succeeding Lecture on February 2.)

King's College, at 5.30.—Dr. F. A. P. Aveling: The Human Will (3) Post-Renaissance Views.

TUESDAY, February 2.

King's College, at 5.30.—Miss Hilda D. Oakeley: Philosophy an History (1). History in the Absolutist Philosophy.

University College, at 5.30.—Miss M. A. Murray: Primitive Cults in Ancient Egypt.

WEDNESDAY, February 3.

University College, at 5.30.—B. M. Headicar: The London Schoo of Economics Library, its Work and Methods.

THURSDAY, February 4.

University College, at 4.30.—Prof. E. G. Gardner: The Florentin Academies in the Renaissance.

King's College, at 5.—Dr. J. A. Hewitt: Metabolism of Carbohydrat and Fat. (Succeeding Lectures on February 11, 18, 25, March 4, 11.)

SATURDAY, February 6.

Horniman Museum (Forest Hill), at 3.30.—W. J. Perry: The Quest fo Gold and Pearls in Ancient Times.

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SATURDAY, FEBRUARY 6, 1926.

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The Status of the Naval Engineer.

On November 20, 1925, the Admiralty issued a Fleet Order which, while to some extent affecting all branches of the Navy, has raised serious questions regarding the future status of the officers of the engineering branch. Hitherto there have been five branches in the service, but this order brought into being thirteen separate categories. Some of these, however, such as the dental branch, the schoolmaster branch, and the wardmaster branch, are but small sections of the personnel. The branch principally affected is the engineering branch, and the situation created by the order was felt to be so adverse to the best interests of the service that Lord Weir, Sir Charles Parsons, Sir John Thornycroft, and Sir Archibald Ross jointly addressed a letter to the press on the subject. This letter has been followed by other communications and articles, and on January 14 a deputation representing the Institutions of Civil Engineers, Mechanical Engineers, Naval Architects, and Electrical Engineers, and also the North-East Coast Institution of Engineers and Shipbuilders, waited upon the First Lord of the Admiralty (the Right Hon. W. C. Bridgeman) to place their views before him. So far no account of this deputation has been made public, but we can scarcely think that representations made by such a responsible body will be disregarded.

There have been engineers in the Navy now for more than a hundred years, and in the struggle of the engineer officers for adequate recognition there have been many memoranda, petitions, and deputations, but never before have the four founder engineering institutions taken so notable a step as that referred to, and their action can be taken as significant of the importance of the questions raised. It is therefore only right that the main points at issue should be made as clear as possible, so that whatever the results of the deputation, the whole position may be judged impartially.

It may, however, be said that no reasoned opinion on the engineering question can be formed without a knowledge of the past, and thus a few brief historical notes will be of use. Steam vessels appeared in the Navy so long ago as 1820. At first they were small dispatch vessels, and the engineers were mechanics of little or no education. By 1837 the steam frigate had been evolved, engines had become larger, and the engineers were given warrant rank. With the coming of the screw and its adoption in the old line-of-battleships, the steam department grew apace, and in 1847 engineer officers were raised to an equality with the masters and assistant masters who then comprised the navigating branch. Even at that time there was a scheme for training boys for naval engineering duties, but this did not amount to much, and when the Crimean War was in progress, recruits had to be sought for over a wide area. By the 'sixties the boys had become engineer students, who were taught in the Dockyard Schools, and some of these passed to the Royal School of Naval Architecture and Marine Engineering at South Kensington. The officers so trained were the best marine engineers of the day, but when they entered the service they found themselves subjected to all sorts of disabilities as to pay, half-pay, promotion, retirement, accommodation, and relative rank. It is not surprising to know that these unsatisfactory conditions led to great discontent.

A new and promising chapter was opened in 1875 with the appointment of a committee of three executive officers and two engineer officers, Admiral Cooper Key being chairman, to report on the best method of staffing the engine-rooms of the Fleet. That committee was one of the ablest which ever investigated the matter. The members went into the question thoroughly and made valuable recommendations, many of which were adopted. But the most vital recommendation, that engineer officers should in the future belong to the military branch and not to the civil branch, but not to succeed to command, was shelved, and in the failure to adopt that salutary reform is to be found the cause of most of the agitation and dissatisfaction which disturbed the domestic peace of the Navy for more than a quarter of a century, and have again been revived by the recent order.

One of the outcomes of the Cooper Key Committee was the opening of, first, H.M.S. *Marlborough*, and then of Keyham College, as training schools for engineers. Though the latter was starved financially, it had a fine record of success as a technical college, and nearly all the engineer officers who held responsible positions at the Admiralty, in the dockyards, and in the Fleet during the War were men who had passed through its portals.

As it was in the 'sixties and 'seventies, so it was in the 'eighties and the 'nineties. Ships' machinery grew more and more complex, the engineer officers' duties were increased by the addition of new types of machinery, but for all that the Admiralty refused to recognise the engineer as a combatant, and, however absurd it may seem, the officers concerned with the upkeep and running of such vessels as the *Terrible* and *Powerful* were of civilian status.

Through this and other causes the competition for entry into Keyham College, which should have been keen, became almost negligible, and the avenues of entry into the engineering branch had to be thrown open wider and wider while the standard of attainments of the candidates became lower. In spite of this, the numbers forthcoming were insufficient and the staffing of the engine-rooms at the end of last century became so difficult as to constitute a national danger.

This was the position when, through the initiative of the late Mr. D. B. Morison, the engineering institutions of the north took up the question of reform and focussed public attention upon it. Papers were read at Newcastle, Glasgow, and elsewhere, and in 1901 a deputation representing the shipbuilding and engineering world was received by the Admiralty.

The result of this propaganda, together with the difficulties of the authorities in obtaining engineers, was somewhat unexpected. At the end of the year 1902 the Navy was startled with the oft-quoted Selborne Memorandum. Issued by the First Lord, this was really the work of the late Lord Fisher. By that memorandum, the entry, training, and careers of naval officers were reformed from top to bottom. Deck officers, engine-room officers, and marine officers were to be entered together, trained together, serve together, and their duties were to be interchangeable. In the words of the memorandum, every naval officer was to be "a seaman, a gunner, a soldier, an engineer, and a man of science." That scheme, it may be remarked, never had any considerable body of engineering opinion behind it, and many engineers declared it to be impracticable, as experience has indeed shown it to be.

While, however, the Selborne plan of naval training has had to be modified almost out of recognition, it had two excellent features, common entry and equality of status, and these were its chief legacies. The commanders (E.), the lieutenants (E.) who have passed through Dartmouth, were all, until November last, executive officers like lieutenants (G.), (T.), and (N.) who have specialised in gunnery, torpedo, and navigation. They had the same commission, they wore the same uniform, but by becoming engineers had forfeited the right to command. They in fact represented the engineer as suggested by Admiral Cooper Key in 1876 as belonging to the military branch, not the civil branch, but they were not to be allowed to succeed to command.

It may be asked, What became of the older engineer officers who were already in the Navy when the Selborne scheme was introduced? What difference did the new plans make to them? Practically none It is true they were given semi-military titles such as engineer commander and engineer lieutenant, but they remained members of a civilian branch. Th engineer officers who fought in the Bight of Heligoland, who lost their lives at Coronel, and those who drove the *Inflexible* and *Invincible* into action at the Falklands, all fought as civilian officers.

The removal of this anomaly was the result of war. At the end of 1914 the Admiralty made all engineer officers part of the military branch, and thus for the first time recognised their importance. Many were the tributes paid to the engineering branch during the War, and when military status was conferred, Lord Fisher telegraphed to Mr. Morison: "The unapproached efficiency of our engineers in the Navy merited this tardy recognition of their all-important part in the present splendid fighting condition of our whole fleet, and this has been combined with an unswerving loyalty to a changing system which they one and all recognised to be for the public benefit and the good of the Navy." The effect of the new order was felt right throughout the service. The engineer officers were proud of the distinction conferred upon them, and it has been their aim ever since to uphold the highest traditions of the branch to which they were admitted.

It will be seen that the position attained by the naval engineer has only been gained through a long process of evolution. But to-day he unfortunately stands shorn of the military status so tardily given. The Fleet Order of November, by a stroke of the pen, abolishes the military branch and creates a new executive branch from which all engineer officers are excluded. Is it any wonder that parents of young officers, officers themselves throughout the Fleet, and the engineering profession generally, regard the action of the Admiralty as a grave breach of faith? To criticism, the reply is made that the executive officers might equally complain that with the abolition of the military branch they have been deprived of military status. Such a reply is altogether untenable. In a fighting service there must always be a military branch. You may call it by another name but you cannot get rid of it, and to-day the new executive branch stands in the place of the old military branch while the engineer officers are practically reduced to civilian status again.

After all these years, it is indeed high time that the entry, the training, the status, and the appointment of engineers should be placed upon a sound and permanent basis, and Mr. Bridgeman can do the Navy no higher service than by removing these things from the realm of uncertainty, and thus preventing the recurrence of the deplorable controversies which have marked the progress of the naval engineer in the past. The first step, however, is the restoration of military status.

Steel and the Nation.

Metallurgy and its Influence on Modern Progress: with a Survey of Education and Research. By Sir Robert A. Hadfield. Pp. xvi + 388 + 71 plates. (London: Chapman and Hall, Ltd., 1925.) 25*s*. net.

THE author of this handsome volume has played an active part in the metallurgical world, as the head of a famous firm of manufacturers, as an inventor and investigator, and as the president of several technical societies. He has received many public honours, and has been prominent in the life of his city and of the industrial community. Above all, he is personally acquainted with most of the leaders of industry, of physical science, and of education in this and several other countries, and has kept in close touch with related movements, so that he brings to the task of writing a book on metallurgy an exceptionally wide range of experience. From time to time, in presidential and other public addresses, he has reviewed the progress of science and invention, the scope and objects of education, and similar subjects, and it is the material of those addresses, expanded and supplemented by other matter, which has been recast into the form of the present volume, which is well and lavishly illustrated.

The work is not easily classified, being in part a history of metallurgical and engineering industries and of the sciences on which they are based, in part a detailed account of the nature and properties of certain selected systems of alloys, and in part a review of the place of science in the community and of the forms of education best suited to a nation which depends on manufactures for its existence. The metallurgy considered is that of steel, the non-ferrous metals being ignored. The author has written of those things in which he is himself interested, and has made no attempt to construct a systematic treatise.

After a preliminary sketch of the history of the subject, the influence of carbon on iron is considered, leading up to an account of the development of alloy steels. Next follows a description of the two alloys with which the name of Hadfield is chiefly connected, the remarkable manganese steel which was the first of the alloy steels to be investigated thoroughly and still remains unique in its curious combination of toughness and resistance to wear, and the silicon iron which is now in general use for electrical transformers, having a high permeability with a high resistance. The history of these two inventions and of their gradual adoption by the industries is told at length in an interesting fashion, with many personal reminiscences of the men who were associated with the work. The story is most instructive in regard to the importance of research for industry. Other steels are dealt with more briefly, this section containing an account of armour-piercing projectiles, treated in a popular manner, with comparisons with other moving masses in regard to the energy content. Some striking facts concerning steel castings are also included.

Another section of the book is devoted to the subject of fuel economy, and contains some more technical matter in the form of curves and calculations intended to assist the metallurgist in the efficient design and use of furnaces. Stress is laid on the importance of correct design, and on the value of scientific investigations into the flow of gases in that connexion, the pioneer work of Groume-Grjimailo being corrected by the calculations of later workers. The name of Wheeler has been overlooked in this review of fuel economy, although his contributions to the subject are among the most important.

The last portion, dealing with the facilities for technical education and research, is perhaps the least satisfactory, being a collection of paragraphs of very unequal importance, and so failing to produce the right effect of perspective. It is largely devoted to an account of the leading technical and professional societies, beginning with the Royal Society, and as such is of considerable interest, being supplemented by biographical notes on the men who have been chiefly responsible for their growth, but there is only a brief mention of the institutions for the training of metallurgical students, giving an inadequate survey of the facts on a matter which might be expected to receive full attention in such a work. In describing institutions specially designed for research in metallurgy, a detailed list of the apparatus included in the equipment of the Japanese Institute at Sendai is given, without mention of the fact that equally if not more important installations are to be found elsewhere, as, for example, in the National Physical Laboratory, the University in the author's own town of Sheffield, and the Bureau of Standards at Washington, whilst other great laboratories, such as the Metallographic Institute of Stockholm and the Kaiser-Wilhelm Institute at Düsseldorf, produce work of probably equal importance. The omission of the last-mentioned reminds one that the author, in his effort to show that the value of German research in chemistry and the allied sciences has been overrated, almost completely ignores Germany, Wedding and Ledebur being practically the only German metallurgists whose work is mentioned.

Whilst it is legitimate and useful to direct attention to the originality and sound character of English and French research, and to the remarkable industry of the Japanese workers, the effect of such a presentation is to produce a wrong impression, and students of metallurgy at the present day for the most part acknowledge gratefully the value of German research. The great advances in the study of high temperatures due to the labours of the staff of the Geophysical Laboratory of Washington also deserve recognition. Should the author have occasion to revise his work, this defect could easily be remedied, as the information is readily accessible. The lists of distinguished investigators which appear in various parts of the book appear to have been drawn up somewhat at haphazard, and some omissions are certainly quite accidental. Thus, on p. 16, the names of Newlands and Lothar Meyer are omitted from the list of workers on the classification of the elements, whilst lower, under radioactivity, the name of Curie appears without any indication that it covers two investigators. On p. 174, the preparation of the early high-speed tool steels is attributed to Maunsell White alone, Taylor not being mentioned, whilst on p. 292 Ramsay alone is referred to in an account of the discovery of argon, Lord Rayleigh being omitted. Such slips are clearly accidental, and might have been remedied during the reading of the proofs.

The author's enthusiasm for his subject, and his conviction of the value of research, are obvious throughout. As an appendix, he includes a verse translation by L. P. Sidney of an eighteenth-century Latin poem, "Ferrum," by a French Jesuit named de la Sante, containing much curious metallurgical information. The poem was translated into French by Floris Osmond, but has not hitherto appeared in English.

All who are interested in the future of industry should read this book, since the history of alloy steels is typical of modern progress in manufacture, and its lessons have a much wider application than might be supposed from its specialised character.

Medicine in the Middle Ages.

(1) *History of Medicine.* (Oxford Medical Publications.) By Prof. Dr. Max Neuburger. Translated by Ernest Playfair. In two vols. Vol. 2. Part I. Pp. viii + 135. (London: Oxford University Press, 1925.) 7*s.* 6*d.* net.

(2) *The Evolution of Anatomy: a Short History of Anatomical and Physiological Discovery to Harvey; being the Substance of the Fitzpatrick Lectures delivered at the Royal College of Physicians of London in the Years 1923 and 1924.* By Dr. Charles Singer. Pp. xii + 210 + 22 plates. (London: Kegan Paul and Co., Ltd., 1925.) 12*s.* 6*d.* net.

(1) WE have had to wait a long time for the second instalment of Prof. Neuburger's "History of Medicine"; but it is well worth waiting

for. Even though it is only a part of the second volume that he gives us now, it covers the most interesting and romantic phase of the history, a period that few writers could have interpreted with such competence and recognised authority.

In particular, Prof. Neuburger's literary skill gives the book its distinctive character. His lucidity and sense of style make his writing a pleasure to read, and Dr. Playfair has happily transferred these qualities into idiomatic English.

> "Western Medicine in the Early Middle Ages is, strictly speaking, hardly a subject for the historian of science who would present a coherent picture of progressive events—at the utmost sidelights can be thrown upon medical conditions and literature, in as far as the very scanty information at our disposal makes this possible. Inadequacy of scientific principles, total stagnation of investigation, practice devoid of any lofty outlook, stereotyped and primitive, these are the characteristics of this era's healing art, an art which in its manifestations is almost reminiscent of the earliest stages of medical evolution. Gloomy as is the impression left upon the mind, the close connection of medicine with civilisation as a whole and its historic destiny, come unmistakably to the fore, and its fate in this mournful period is bound up more intimately than usual with the spirit of the times."

To deal adequately with this difficult problem called for the wide and exact scholarship and industry which Prof. Neuburger has devoted to his task. He has given us a graphic picture of how Europe gradually emerged from its five centuries of lethargy and acquired from Arabic sources a second-hand acquaintance with Greek medicine. The revival of classical learning completed the process of making Europe the heir to the knowledge of antiquity and the learning of the Greeks.

The present instalment of Prof. Neuburger's book deals with the obscure period of the early Middle Ages, the state of medicine in the eleventh and twelfth centuries, the coming of Arabic influence into western science, and the effects of this upon the development of medicine in the thirteenth century and the later Middle Ages, elucidating the circumstances in which the development of modern scientific methods and the reliance upon direct observation and experiment were introduced.

It is difficult to give a summary of this fascinating work. Every one interested in the history of science will have to read the whole volume for himself. The history contains ample references to authorities, and includes an extremely useful historical survey of literature. It is full of interesting side-lights on the history of civilisation, with which only a man of exceptional knowledge and human sympathy could have illuminated the history of medicine. We may perhaps be permitted to give an illustration of these qualities. Describing the emancipation of science from the shackles of scholasticism—a process which can be seen happening in the case of anthropology in our own day—Neuburger gives this graphic picture of Roger Bacon's unhappy experience as a pioneer before the times were ready for his reforms :

> "Since Albertus Magnus remained without a true successor in the domain of natural science, and never broke the bonds of the prevailing mode of thought, but only succeeded in providing the possibility of a reconciliation within certain limits between unbiassed observation of facts and scholasticism, it cannot be a matter of surprise that the premature movement in favour of the emancipation of scientific investigation from dialectic oppression, on an exact foundation upon a basis of observation and experience by the aid of mathematics and experiment, should find no support, but should be met by misunderstanding, even by embittered enmity. It was the English Franciscan, Roger Bacon, who once more initiated this movement, a truth-seeker and pioneer of comprehensive knowledge and intuitive perception, a thinker of unyielding austerity of thought, who paid for his great superiority over his age with a lifetime's martyrdom, but whose name can never be erased from the annals of the intellectual development of mankind so long as the light of scientific freedom shall shine." (P. 58.)
>
> "Unfortunately the fruitful and almost unique influence of this great man, who aimed at a reform of science and education, was only too early interrupted. Envy and unpopularity which followed on the heels of initial admiration and which grew as the result of certain utterances of Bacon's upon the ignorance of eminent scholars and upon the immorality of the monks, suspicion which caused his incomprehensible scientific researches and superior knowledge to be looked upon as devilish arts, culminated eventually in serious charges which, though for a while repelled, finally found credence amongst his superiors, after Bonaventura had succeeded to the generalship of the Franciscan order. Bacon was taken in 1257 from Oxford to the House of the Order in Paris, where he had to submit to various penalties and was placed under strict supervision, whilst from this time onwards he was deprived of freedom to commit to writing his ideas and discoveries. A last ray of hope penetrated to the investigator thus doomed to silence when the newly elected Pope Clement IV., who in earlier days had been friendly inclined to him, in 1266 extended to him in profound secrecy the permission to elaborate his views and plans for reform and to submit them by way of justification." (P. 59.)

(2) In the Fitzpatrick lectures delivered by Dr. Charles Singer to the Royal College of Physicians in 1923 and 1924, the substance of which is now published under the title of "The Evolution of Anatomy," an interesting sketch is given of the history of anatomy from the earliest times. Men of the Upper Palæolithic period showed their knowledge of the heart in the cave pictures of France and Spain, which seem to indicate that already they had formulated theories of the life-giving power of blood. The Egyptians and the Babylonians struggled

in the dark for many ages before the Greeks got rid of the trammels of hieratic obstruction that prevented the free development of knowledge and rational methods. Dr. Singer's story really begins with the Greeks and follows the history throughout the intervening centuries until our own William Harvey introduced a new epoch in scientific medicine and experimental physiology.

Dr. Singer's book is a comprehensive and lucid story well adapted for the use of medical students and of the general reader who wants an easily understood account of the chequered career of medical science.

One of the outstanding features of the book is the interesting collection of reproductions of ancient anatomical figures; in particular, the illustrations from the "Epitome" of Vesalius. For the teacher of anatomy who cannot devote much time to the teaching of history in the course of his normal work, this book will be particularly welcome, as it provides a body of important information to which every medical student should have easy access. It reveals the age-long struggle that was necessary to acquire the knowledge of human structure and the facilities for studying practical anatomy with complete freedom which the student enjoys to-day. Dr. Singer's book should bring these facts home to him, and also impress upon him a feeling of gratitude and respect for the men who by their own sacrifices secured these liberties. G. ELLIOT SMITH.

The Witch Cult.

Witchcraft and the Black Art: a Book dealing with the Psychology and Folklore of the Witches. By J. W. Wickwar. Pp. 320. (London: Herbert Jenkins, Ltd., 1925.) 8*s.* 6*d.*

INTEREST in the occult is perennial and widespread; but the appeal of the witch is especially strong to all those who cherish their little superstitions but do not take them too seriously. Although real belief in the witch is no doubt dying, it is dying slowly. Reports of cases in country courts in which witchcraft is involved in some way or another are of sufficient frequency to show that it still has a strong hold on the countryside. Quarrels over bewitched cattle, sometimes followed by assaults in which the witch was "scored above the breath," that is, scratched on the forehead, as a protective measure, point to an identity of mental attitude in the modern peasant and his ancestors as far back as we can go in the records of popular and primitive belief.

Mr. Wickwar's "Witchcraft and Black Magic" is a popular account of witchcraft, in the main historical, but written throughout from the point of view of the student of the lore of the folk and the underlying survivals of primitive religion and magic. "Witchcraft," he says, "had its real inception in a period of fear, wonder and sacrifice common to all primitives." He deals with the belief as it existed in England only, excepting for one chapter in which he briefly recounts the rise and progress of witchcraft prosecutions on the Continent, which resulted in an appalling death roll in France, Germany, and northern Italy. Mr. Wickwar traces the history of the cult from the third to the eighteenth century, when the mania of the sixteenth and seventeenth centuries had died down and the attitude of the more enlightened members of the community had become such as is indicated by the change in the law relating to witchcraft brought about by the Act of George II. in 1735. By this Act the real existence of witchcraft ceased to be recognised, and it was relegated to the realm of superstition and fraud. Prosecutions for witchcraft were abrogated, and *pretence* to practise witchcraft became the indictable offence.

The history of the witchcraft belief is extremely interesting, but its exact interpretation is by no means clear. Miss Murray has suggested that witchcraft was a genuine cult, a survival of a primitive ritual practised by the covens—the assembly of twelve witches with their leader—and connected with fertility rites. Pagan rites certainly survived after the introduction of Christianity, as was recognised by St. Augustine according to the records of the Venerable Bede, and documents of the seventh, eighth and following centuries refer to survivals of pagan ritual which might well be the basis of a witchcraft cult. Walter Mapes also describes a ceremonial attributed to an heretical sect in which the procedure is similar in certain elements to a witches' sabbath. In most of the early cases of witchcraft, however, the delinquents are guilty of magical-practices rather than witchcraft in the strict ritual sense. Such, for example, was the attempt by Lady Cobham against the life of Henry VI., and of the Duchess of Bedford, who wished Edward IV. to marry her daughter.

When witchcraft became a form of heresy under the Bull of Innocent VIII., in 1484, the head and front of the offending was not merely the employment of magical means to accomplish some end, but the renunciation of the Church, the voluntary execution of a covenant with the devil, and the entry into the communion of witches. Mr. Wickwar accounts for the difference by holding that in the course of its history between the third and the seventeenth centuries the character of the belief changed. He accepts the view that witchcraft was a really existing cult which had survived from a primitive form, though at a later stage he appears at times to write not quite consistently when dealing with the part played by the Church in conducting the great prosecutions of the fifteenth, sixteenth, and seventeenth centuries. Granting the survival of a great deal of primitive belief in medieval and modern times, a careful examination of the character of the evidence in the great witch trials makes it difficult to accept the survival of a real cult, notwithstanding the undoubted fact that *belief* in its existence had persisted. How real was the latter is shown by the literature extending from the "Malleus Maleficarum" of 1489 to the writings of Webster, Glanville, and Hutchinson, when in the course of the controversy, belief in witchcraft was both a heresy and a test of orthodoxy. This is one of the most interesting and instructive chapters in the history of religion and literature.

Mr. Wickwar's history of the witch touches upon all its more important features, including lycanthropy, the familiar, the flight of witches, and their sabbaths. He describes the most striking of the cases which came to trial in a way which carries the reader with him, while he successfully skirts the more repellent features of the subject. There are a few slips here and there, probably due to misprints; otherwise Mr. Wickwar's work is commendably accurate.

The Theory of Measurement.

The Theory of Measurements. By Dr. Lucius Tuttle and Prof. John Satterly. Pp. xii + 333. (London: Longmans, Green and Co., 1925.) 12*s.* 6*d.* net.

THIS is a text-book for university students taking the ordinary course; its scope is indicated by the following abbreviated list of chapter headings: Weights and measures, significant figures, logarithms, the slide rule, graphic representation, interpolation, measurements and errors, least squares. In their preface the authors defend and, in our opinion, justify the novel practice of separating the study of the principles of measurement from that of its applications. They are pioneers, and as such deserve our gratitude; but gratitude must not prevent a careful scrutiny.

Our chief criticism is that the title is misleading and indicates a serious fallacy which pervades the book. The authors have no theory of measurements. They show no signs of having considered what is common to ll measurement and what peculiar to special forms of t, in what conditions measurement is possible, or what accuracy means. Doubtless a thorough inquiry into these matters would be unsuitable for elementary students; but it has been justly said that the writer of text-book should know more about what he omits than about what he includes; we are certain that if the authors had thought more deeply on these fundamental questions, they would have selected and arranged their material very differently.

In particular, they would not have devoted so large a proportion of their space to errors and adjustments or conveyed throughout the impression that these are the things that really matter in measurement. They are of primary importance in observational sciences, which cannot select their material, or in sciences which can hope to attain only statistical laws. In the experimental sciences, which most concern university students, these things are altogether subsidiary. In them the criterion of good measurement is not whether it provides material suitable for the computer, but whether it makes his work unnecessary. It is far more important to the physicist to be able to get a sharp galvanometer spot and know why all electrical magnitudes should be referred to resistance than to be able to handle least squares and know the relative advantages of various expressions of deviation. Rayleigh, a master of measurement and quite capable of handling the most abstruse analytical methods if he had found them valuable, never, we believe, used any method of adjustment more complicated than the taking of an arithmetic mean. Yet our authors have the hardihood—we had almost said impudence—to offer their students a set of Rayleigh's measurements and suggest that they "reject" some of them by Chauvenet's criterion. In this chapter their full error stands revealed. No wise and honest experimenter "rejects" an observation. He may reject the record of an observation on the ground of clerical error; but a really discrepant observation is more valuable than any other. It is always an indication of the limits of the method; it is often the clue to unexpected avenues of research.

However, we recognise that our authors are merely following an evil tradition, and that their fault here is only that they have failed to advance on their predecessors. But even if their general outlook is accepted, their selection and, still more their order, is open to criticism. On what grounds, other than historical, should all statistics be regarded as "applications to biology"? If angles are measured in Chap. iii., why should areas be relegated to the last chapter? If numerical methods of adjustment are discussed at all, surely some method of smoothing other than free-hand drawing might be described. If over-estimate of accuracy is a danger, surely under-estimate is equally serious; the slide-rule may be "sufficient for the great majority of practical calculations," but it is certainly not for many simple laboratory experiments; there is no instrument the student is more liable to abuse. Much more should be said about computation. Few students can add; and the most important fact about "physical arithmetic" to be instilled into them is that it must be right. Accuracy can be acquired by practice alone, but the lack of it so often leads to a preference of graphic methods over simple numerical methods, both quicker and more satisfactory, that no space devoted to aids and checks would be wasted. Calculating machines other than the straight slide-rule are not mentioned, and tables are regarded as books to be read rather than as instruments to be handled. Lastly nomograms, theoretically interesting and practically most useful, are dismissed in a short paragraph.

We hope then that the authors will try again. They have aimed at writing a book that has long been needed, and their attempt is the best, because it is (so far as we know) the only one in the language. If they can make their execution equal to their design, if they will really justify their title, they will indeed deserve the thanks of all who desire reform in the teaching of physical science. NORMAN R. CAMPBELL.

Our Bookshelf.

Technical Education: its Development and Aims. By C. T. Millis. Pp. vii + 183. (London: Edward Arnold and Co., 1925.) 6*s.* net.

ONE of the chief lessons we may learn from a study of the past is that society is neither "in rigid repose with certain . . . institutions rooted like oak-trees in the centre round which all group themselves as best they can," nor is it in such a fluid state that its institutions may ruthlessly be torn down. Roots there are, but they are not eternal, and, although they are not to be pulled up hastily or thoughtlessly, there are among them those which are removable when they no longer fit life's changing conditions.

Mr. Millis's book—and particularly that part of it which reminds us of the debt we owe to the pioneers of technical education—makes us realise this very clearly, and directs our attention to some of the causes which are gradually forcing all concerned with education to examine their theories and practices so that education shall not be divorced from life. Slowly we begin to understand that careers in industry and commerce are worthy of as careful preparation as are those in the "professions." In secondary schools the need of "modern" sides is being felt: enlightened employers, recognising the decay of the apprenticeship system, are seeing that the means of producing an intelligent and adaptable workman already exist within our system of technical education, and would therefore improve and extend that system.

That there is a national urge to examine these questions may be seen from the fact that they are already receiving attention by the Balfour Committee, the Board of Education's Consultative Committee, and the recent Committee set up by the Boards of Education and Trade. An unofficial committee under the chairmanship of the Right Hon. Lord Emmott is also examining the relationships between technical education and other forms of education and industry. In view of these signs of the times, whether one agrees with Mr. Millis's conclusions concerning technical education or not, his book is a distinct contribution to the discussion of questions which are bound to be much to the fore in the coming reconstruction of our ideas both educational and industrial.

Grundfragen der vergleichenden Tektonik. Von Prof. Dr. H. Stille. Pp. vii + 443. (Berlin: Gebrüder Borntraeger, 1924.) 22·50 gold marks.

THE most valuable part of this important work is the very full account, occupying some 200 pages, of all the epochs of mountain-building since the close of the pre-Cambrian. A very clear picture of the geological structure of Europe is brought out, starting with the primeval Europe of the pre-Cambrian shields, and continuing through the main tectonic subdivisions built up by the successive phases of Caledonian, Hercynian, and Alpine movements. Altogether about twenty definite phases are recognised. Three of these are grouped as Caledonian (Ordovician to Lower Devonian); five as Variscan or Hercynian (Upper Devonian to Permo-Triassic), and the rest as Alpine (Kimeridgian to recent). The broad periodicity often referred to in text-books clearly cannot be accepted except for limited areas. Dr. Stille continues to hold the view that earth-movements are mainly due to the contraction of the outer crust, a theory that is at present subject to very severe criticism from various sources. But although the author says nothing of the possibility of expansion, and little about isostasy, he maintains, in opposition to Suess, that upward movements have occurred not only relatively to downward movements, but also with reference to the centre of the earth. It is a great pity that the details of igneous activity have not been included with those of earth-movements. The task of compiling all the information must have been a heavy one, but a little more work would have sufficed to make the book a storehouse of petrological data of the utmost value. As it is, we are indebted to Dr. Stille for the most complete account that has yet appeared of the earth-movements of Palæozoic and later times.

Electric Vehicles. By Charles W. Marshall. Pp. xi + 96 + 25 plates. (London: Chapman and Hall, Ltd. 1925.) 9*s.* 6*d.* net.

THE class of electric vehicle which has proved mos successful in Britain up to the present time is th lorry of from 1 ton to 5 tons capacity. The autho has had extensive experience of the working of electri battery vehicles belonging to the Glasgow Corporation and he quotes test figures which are very interestin and instructive. He compares the cost for electric petrol, and steam motors and shows that the electri vehicle is cheapest to run, provided that the loa capacity lie between 2 and 5 tons. For loads of les than 2 tons, the petrol vehicle is the most economica But electric vehicles are preferable in every way t horse-drawn vehicles. The average consumption energy for a ten-mile run is generally about a uni It is rightly pointed out that electric vehicle builde are greatly handicapped in their endeavours to indu private firms to use electric vehicles by the fact th most electricity authorities have no vehicles of th type themselves. It would pay the municipal electr authorities if all the city work at present being do by horses were done by electric vehicles. For ea horse displaced a night load on their station of abo one kilowatt for seven hours would be obtaine Valuable data are given which should enable enginee to come to a decision.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Radiation arising from the Mutual Annihilation of Protons and Electrons.

THE recent work of Millikan (*Science*, 62, 444, 1925) has added to our list of radiations, some of far shorter wave-length than any hitherto discovered. By extrapolation of A. H. Compton's formula for absorption (*Phys. Rev.*, 21, 483, 1923), it has been estimated that these new rays have a range of wave-lengths between 0·0004 and 0·00067 Ångström. (Had the analogous formula developed by Jauncey (*Phys. Rev.*, 22, 233, 1923) been used, the values would have been between 0·0022 and 0·0029) It is suggested in Millikan's article that "the computed frequencies of these rays also correspond closely to the energy involved in the simple capture of an electron by a positive nucleus."

It seems worth while looking into the possible ways in which the capture of an electron by a proton can be effected, and considering how it can be done with the minimum sacrifice of what are usually considered to be basic principles. In attempting to speculate on the origin of extremely high frequency radiation according to the line of thought indicated, it may be well to set down what principles we should endeavour to retain. These are:

(*a*) Conservation of energy.
(*b*) Conservation of momentum.
(*c*) Conservation of charge.
(*d*) Reversibility of process considered.
(*e*) Velocities never to exceed the velocity of light.

(*a*), (*b*), (*c*), and (*e*) need no comment. As to (*d*), a word of explanation may be necessary. From considerations involved in the discussion of Klein and Rosseland's "collisions of the second kind" and implied in Einstein's derivation of Planck's formula, and particularly from the work of R. H. Fowler and E. A. Milne on the equilibrium of ions, atoms, excited atoms, and radiation, it has appeared necessary to demand that each elementary process involving the emission or absorption of radiation and a change of state of the atom, etc., must be individually reversible. It seems desirable in the speculations now under consideration to favour the solution in which the reversibility is not too difficult to realise.

We shall now consider various ways in which a quantum can be produced by the mutual annihilation of an electron and a proton on collision in which the energy of the quantum is supplied by the mass energy annihilated.

The conservation of energy requires that the energy, $h\nu$, in the quantum of radiation generated, should be equal to the combined energy of the proton and electron, Mc^2+mc^2, where M and m are their respective masses.

$$h\nu = Mc^2 + mc^2.$$

If we make no attempt to see that any of the other principles enumerated above are satisfied, we can at once proceed to calculate the wave-length. Neglecting m in comparison with M, we have

$$\lambda = \frac{h}{Mc} = 1\cdot3 \times 10^{-13}\ \text{cm.} = 1\cdot3 \times 10^{-5}\ \text{Å.U.}$$

This is apparently what Jeans has done (NATURE, December 12, 1925, p. 861), for this value is identical with his. It will be observed that this value is thirty times less than the minimum wave-length of the new high frequency radiation as estimated by Millikan.

In the foregoing, conservation of momentum is ignored completely. If we attempt to secure conservation of momentum, then the momentum of the quantum must be equal to that of the disappearing electron and proton. Let us assume that, after collision, the quantum is moving along the OX axis, and that, before collision (which occurs at the origin), the proton and electron are moving respectively with velocities v_1 $(=\beta_1 c)$ and v_2 $(=\beta_2 c)$ and in paths making angles of ϕ and θ with the OX axis. If M and m be their masses, the conservation of energy requires

$$\frac{Mc^2}{\sqrt{1-\beta_1^2}} + \frac{mc^2}{\sqrt{1-\beta_2^2}} = h\nu. \qquad (1)$$

The conservation of momentum requires

$$\frac{M\beta_1 c}{\sqrt{1-\beta_1^2}}\cos\phi + \frac{m\beta_2 c}{\sqrt{1-\beta_2^2}}\cos\theta = \frac{h\nu}{c}, \qquad (2)$$

and

$$\frac{M\beta_1 c}{\sqrt{1-\beta_1^2}}\sin\phi = \frac{m\beta_2 c}{\sqrt{1-\beta_2^2}}\sin\theta. \qquad (3)$$

On multiplying (2) by c, and comparing with (1), it is quite evident that both equations cannot be satisfied simultaneously, since $\cos\theta$ and $\cos\phi$ cannot exceed unity and β_1 and β_2 are necessarily less than unity. There is also a great difficulty in imagining the reverse process, which would evidently require a single quantum to disappear spontaneously, without apparent cause, and a proton and electron to appear in its place. The disappearance of the quantum on collision with some object is conceivable, but its sudden disappearance at some instant, without anything to mark that instant as different from any other instant, is contrary to our notions of cause and effect.

If we consider a three-body collision, between *two* electrons and *one* proton, resulting in a quantum and one electron, we can find a solution which satisfies all the conditions (*a*) . . . (*e*). Let us suppose (as a special case) the two electrons and the proton to be initially at rest before collision and the surviving electron to go off with a velocity v $(=\beta c)$ after collision. The energy and momentum equations are

$$mc^2 + mc^2 + Mc^2 = h\nu + \frac{mc^2}{\sqrt{1-\beta^2}},$$

$$0 = \frac{h\nu}{c} + \frac{m\beta c}{\sqrt{1-\beta^2}}.$$

Solving, we find

$$h\nu = \tfrac{1}{2}Mc^2\frac{\left(1 + 4\dfrac{m}{M} + 3\dfrac{m^2}{M^2}\right)}{\left(1 + 2\dfrac{m}{M}\right)},$$

or, neglecting quantities of the order of m/M,

$$h\nu = \tfrac{1}{2}Mc^2,$$

whence

$$\lambda = 2\cdot6 \times 10^{-13}\ \text{cm.} = 2\cdot6 \times 10^{-5}\ \text{Å.U.},$$

and

$$\beta = 0\cdot999998.$$

Reversibility of the process in this case is easily visualised, for the quantum would disappear only on collision with an electron of energy $(1/2)Mc^2$ (neglecting quantities of the order of m/M). It is evident that the generation of high frequency radiation can result from a three-body collision without violating any of the principles enumerated above. (The quantum and recoil electron will, of course, travel in opposite directions, but there is nothing to determine the orientation of the line in space.)

We can generalise this three-body encounter by supposing that, before collision, one electron is moving with *any* velocity in *any* specified direction, with respect to the direction of motion of the resulting quantum. It turns out that in this case the quantum can have any energy between (1/2) Mc^2 as a lower limit and infinity as an upper limit. A three-body collision between *two* protons and *one* electron resulting in a quantum and one proton will also satisfy all the specified principles $(a) \ldots (e)$. In this case, the energy and momentum equations are

$$Mc^2 + Mc^2 + mc^2 = h\nu + \frac{Mc^2}{\sqrt{1-\beta^2}},$$

$$0 = \frac{h\nu}{c} + \frac{M\beta c}{\sqrt{1-\beta^2}}.$$

Solving, we get

$$h\nu = \tfrac{1}{2}Mc^2 \text{ (approx.)},$$

from which

$$\lambda = 1\cdot7 \times 10^{-13} \text{ cm.} = 1\cdot7 \times 10^{-5} \text{ Å.U.}$$

and $$\beta = 0\cdot6.$$

It is very evident, therefore, that a three-body type of collision is much more satisfactory than a two-body type—as a possible explanation of the origin of the high frequency radiation.

It has been suggested that formation of the helium nucleus from four protons and two electrons will give rise to a high frequency quantum. The value of λ can be shown to be 0·0018 Å.U. It may also be shown that this process will satisfy the conservation of momentum and, moreover, that the reverse process is easily realised, being merely the break-up of a helium nucleus on the impact of the quantum.

It is evident that if we consider the possibility of collisions involving nuclei of atoms other than hydrogen, there is a wider field for further investigation and speculation.

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G. E. M. JAUNCEY.

Washington University,
St. Louis, U.S.A.,
January 4.

Three Fundamental Frequencies.

IT is possible to equate the quantum and the relativity expressions for energy, and thus to obtain three interesting and fundamental frequencies, with their corresponding wave-lengths.

The well-known quantum expression is $h\nu$, where h is Planck's constant and ν the frequency equal to c/λ, where λ is the wave-length.

On the other hand, the relativity form of energy is mc^2, where c is again the velocity of light and m is the mass under consideration.

We have then $h\nu = mc^2$ or $hc/\lambda = mc^2$,

whence
$$\lambda = \frac{h}{mc} = \frac{6\cdot55 \times 10^{-27}}{3 \times 10^{10} m}$$
$$= 2\cdot18 \times 10^{-37}/m.$$

In the first place, put $m = 9\cdot0 \times 10^{-28}$ gm., the mass of an electron, and we have $\lambda = 0\cdot0242$ Å.U., which would be the wave-length due to the complete disappearance of the mass of a slow electron when, if ever, it reappears as radiation.

If, however, m is given the value of the mass of the hydrogen atom ($1\cdot64 \times 10^{-24}$ gm.), we find λ is $1\cdot33 \times 10^{-13}$ cm. This is the wave-length of the cosmic radiation to which Jeans refers (NATURE, December 12, 1925, p. 861), when he contemplates the disappearance of the equal charges and of the unequal masses of the proton and electron, and their reappearance as the most penetrating radiation of which we have at present any conception.

Finally, we can give to m the value derived from the congestion of four hydrogen atoms, each with atomic weight 1·008, into a single helium atom, with 4 as atomic weight. The available mass convertible into radiation is now $4 \times 0\cdot008 \times 1\cdot64 \times 10^{-24}$ gm. or $0\cdot032 \times 1\cdot64 \times 10^{-24}$ gm. This gives the wave-length λ a value of 0·0004 Å.U., or 4×10^{-12} cm. This is the wave-length of the penetrating radiation referred to by Millikan as of cosmic origin in a recent contribution to *Science* (November 20, 1925, p. 445).

To sum up—

$\lambda = \frac{h}{mc}$ leads to three basic wave-lengths,

	Electron.	H atom.	He from H.
$m =$	$\frac{1}{1800}$	1	0·032

$$\lambda = 0\cdot024 \text{ Å.U.},\ 0\cdot000013 \text{ Å.U.},\ 0\cdot0004 \text{ Å.U.},$$

where m is expressed in terms of the mass of a H atom $1\cdot64 \times 10^{-24}$ gm., and Å.U. denotes the Ångström unit or 10^{-8} cm. The reversals of such transformations, when each radiation changes into its corresponding mass, are readily conceived and may indeed occur in Nature under conditions at present unknown, for indeed such changes are not yet within our experience.

M. HOME.

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January 5.

New Mutations in *Gammarus chevreuxi*, Sexton.

SINCE the publication of the account of the first mutations in *Gammarus chevreuxi* (*Journ. Mar. Biol. Assoc.*, vol. 11, No. 3, 1917) a number of new mutations have appeared. Most of these, like the first, are connected with the eye, particularly with its colour and shape, but the most striking of all the new departures is a change in the colour of the *body*.

In the normal *G. chevreuxi* the body is pale green in colour with two bright red patches on each of the pleon-segments, and bars of brown pigment on the antennæ. The fully adult female looks much darker than the male, owing partly to a difference in the green colour, bluish in the female, yellowish in the male, and partly to the dark green, almost blackish, tint of the gonads which show through the transparent cuticle. The eggs, which are dark green when first laid, gradually change to yellow as the embryos form, and then to a deep orange colour just before the young are hatched. In the new mutation the animals are a translucent pearly-white, with no tinge of colour in the body. The gonads show as opaque white stripes, and the eggs in the brood pouch during the whole period from deposition to hatching can only be seen by transmitted light.

We have now three distinct new stocks producing mutations, the stocks having originated from three independent black-eyed pairs brought in from the wild. In all three stocks, as in the original mutating stock, red-eyes appeared which were recessive to black-eyes. We had therefore first to ascertain whether we were dealing with different and distinct mutations, or simply with re-appearances of the old form. To do this, we cross-mated the red-eyed recessives of the four stocks in as many ways as possible. Whichever way the mating was made *the offspring were black-eyed*, thus proving beyond doubt that the mutations of the new stocks are distinct from each other and from the mutations of the original stock. The reversionary blacks, as we call this F_1 generation, have been back-crossed to the parent stocks, as well as mated *inter se*, and give in F_2, as would be expected, blacks, and reds of different constitutions.

Two of the new stocks show some specially interesting features. In the first we have two distinct kinds of red-eyes, one the bright red eye, with the usual brilliant scarlet pigment, and the other a very dark red, almost black at birth. The exceptional feature of the latter is that the dark red colour *lightens* as the animal grows older. Sometimes the eye becomes a brilliant red, indistinguishable from the bright red-eye; at other times the periphery of the eye lightens, and the centre remains dark. But however great the change may be in the colour of the eye, the constitution of the animals remains unaffected, for those which have lost all the dark pigment, and those which have retained the most of it, give the same results in the offspring.

In the second stock referred to, in addition to a new red-eye mutation, the white-body mutation described above arose, and connected with it, or linked to it, new eye-colours appeared, namely, the permanent white and the changeling white. The eyes and bodies of both these on hatching are white, the eyes are as large as in the normal animals, perfect in shape and in the reticulation of white pigment between the lenses, possessing also the deep-seated retinal cells but lacking the coloured pigment usually contained in them. The albinos of the original stock also had eyes which were white and lacking in colour, but in their case the absence of colour appears to be due to the degeneration of the eye, and the normal body-colour was unchanged.

It has proved impossible so far to separate the permanent whites from the changeling whites at birth with absolute certainty, though sometimes the changeling-eyes, especially those arising from a mating of white-eye and coloured-eye, have a more creamy tint than those of the permanent whites, a tint approaching primrose colour.

The permanent whites never develop any colour in the body, the gonads or the eggs, but the eyes appear to be of at least three kinds: the pure white, which never shows the slightest tinge of colour; the flushed white, which has a very faint trace of colour, palest pink or purple in two or three ommatidia in the centre of the eye; and purple white, in which a part of the eye, usually the lower portion, is a faint purple-lilac tint.

The changeling whites arose from a mating of white female and red male. They are practically indistinguishable from the permanent whites on hatching, but rapidly develop colour as they grow, both in the body and in the eyes, until in the adults it is impossible to see any difference between the changelings and the normal red-eyed animals; their bodies are green, the gonads and eggs dark green, and the eyes bright red.

We have had more than 25,000 young from this stock, consisting of:

(1) Black-eyes, normal body-colour, which, mated together, give either (*a*) all black, (*b*) black and red, or (*c*) black, red and white young.

(2) Black-eyes, white-body, giving black and white.

(3) Red-eyes, normal body, giving either (*a*) all red, or (*b*) red and white in the proportion of 3 : 1.

(4) Changelings, which give (*a*) red and white in the proportion of 3 : 1 when mated together; (*b*) black, black and red, or black, red and white when mated with the different blacks; and (*c*) all black when mated with recessives from any of the other stocks.

(5) Permanent whites, which give (*a*) all white when mated together; (*b*) black and white when mated with blacks carrying red, or with blacks carrying red and white; and (*c*) all black when mated with recessives from any of the other stocks. When, however, these permanent whites are mated with reds or changelings of their own stock we get the remarkable result that the reciprocal crosses are quite different; thus, any red male of the stock mated with a permanent white female (white gonads) gives all white-eyed young, consisting of whites and changelings, but the reciprocal cross, white male by red female (dark gonads), gives either all red-eyed young if the female is pure red, or reds and whites if the red female carries white (the one mating of this kind gave 25 reds and 42 whites). Similarly white male by changeling female (dark gonads) gives half reds and half whites (the actual figures are 131 reds, 130 whites), whereas the reciprocal cross, changeling male by white female, gives all white-eyed young, consisting of whites and changelings.

We propose to reserve any discussion of the theory of these different matings until the results have been carried further and the numerical details can be published.

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Do we—don't we—what do we—know?

I ESCAPE from Wonderland to find myself in a land still stricken, where Nature has to be taken in lumps. The effect is a little shocking, to one who has been preaching the use of The Looking Glass. Reflexion at the end of the year, indeed, always, tells me that I am a miserable sinner but NATURE (December 19), in a review article on electrical precipitation, makes me out to be a reprobate of a truly awful type. According to one J. S. G. Thomas, whose acquaintance I, unfortunate, do not enjoy, I have dared to "question Simpson's theory" of the development of electricity in thunder clouds, proposed in 1909. Could any crime be more heinous than that of which I am declared guilty: that of bringing in hydrone in explanation of the thunder storm? Apart from the fact, that I have dared no explanation, it is a little difficult to leave the said fair one out, with water, water, everywhere. Even in water, the fundament does do something, I presume.

I do unfortunately find myself unable, at present, to bow to the august authority of a stately meteorologist who says that thunder is made by splitting hairs—in the form of rain drops. Following my friend Paul of Tarsus—overrated person though he be and the unfortunate prototype of that threatening pest of our society, the metaphysician and psychologist, who knows nothing of hydrone and talks only in terms of thinks—I do but suggest that it were well to prove (prufen) the thesis and only hold fast that which is good. No doubt, I am unduly obsessed (as Mr. Wells would say) by or at or with notions derived from the toyings of one Faraday, perhaps an out-of-date philosopher, with a hydroelectric machine devised by a northern namesake of mine.

I am well aware, that the doctrine—"theory" we have no right to call it, as it does not cover the facts—is in accord with the spirit of the times. We live in an age of "splits." A double Bass is only to be found in an orchestra here and there. The road to Mandalay no longer offers any attraction: you can't satisfy at the end, so much glass is being sold, with little beer—glass with scarce "a glass" in it. Still, I have yet to learn that Jupiter Pluvius is overcome by modern methods of "Sparsamkeit" and that he makes noise by shivering his timbers.

If thunder were made of split drops, should there not be much more of it? Moreover, the thunderstorm rains "magnums," never "splits" I believe no bar-parlour will accept the "split" explanation. Meteorologists, I shall be told, don't frequent such places. More's the pity: they would gain sense of humour, if not of proportion They would begin lower down. When I challenge Sir Oliver Lodge and my friend Prof. Millikan of Pasadena to tell me what happens when I rub my stylo on my coat sleeve—well, they hesitatingly murmur something about rubbed-off electrons. I am not taking any at present; the more as I read in a report of the Physical Society, that a piece of flannel may be a happy hunting ground for an explorer with a piece of sealing wax: apparently you can pick up + electricity here and − there, as Tom Tiddler did both gold and silver: for why? As Mr. Belloc has it:

> Here you may put with critical felicity
> The following question: What is Electricity?
> Molecular Activity, say some,
> Others, when asked, say nothing and are dumb.

Even thunder showers are only sometimes negative, I've heard say My feeling is, that we may leave Sirius and its dense companion and instead rub our coat sleeves in wonder We may then make ourselves of some use in this poor loose world, where the protons are supposedly encumbered and overclad with electrons. We are allowing the mathematicians to postulate all sorts of might-be's—and doing far too little to solve the really live problems.

NATURE is again across my path, on the same date (December 19), in a letter on a surface catalytic action in photochemical processes. I will not stop to consider if a "catalytic" action be ever otherwise than a "surface" effect—I have done so in my contribution to the Solvay Chemical Conference (NATURE, August 22, p 294) I would merely direct attention to the paragraph:

"It is a well-established fact that pure hydrogen and oxygen can combine when subjected to radiation of short wave-length," etc

Is it *a well-established fact* that pure hydrogen and oxygen can combine, etc? Do hydrogen and oxygen—the things we so call and know—ever *combine*? Do not their molecules interact and then only when coupled with certain loose companions? Was I not at great pains, not long ago, in NATURE, to direct special attention to H. B Baker's immortal work, often repeated, showing that hydrogen and oxygen do not interact? Is so-called research but a game, like dominoes, to be played without reference to other people's games? What is the use of "research work," undertaken at great expense of private time and public money, if subsequent workers pay no attention to results already obtained, recorded and discussed *ad nauseam*? Such statements necessarily reflect upon the competence of workers. That a mercury surface should exercise the influence described is in no way surprising—indeed, it is to be expected from Lavoisier's observation, that mercury is easily oxidised even when merely heated to the boiling point in air. Let us burn our books, if we cannot use them: they do but encumber our shelves, if left unconsulted and unconsidered.

Lastly, I am across the Huxley lecture (NATURE, December 26). Sir Oliver Lodge has a great name and his opinion counts for much with the public, because of his position in science. Surely, we have the right to ask him to dissociate himself from our body before saying in public: "And what of man? If his death is the end of him, the value of his existence may be doubtful. But if, *as I know* (my italics), that is not the end of him, then there may be infinite progress in store." We of the body scientific know, that we can very rarely say: *I know*, least of all when speaking of the great problem that has exercised the mind of man throughout the ages. Better that we hold on to the advice long since given by the poet:

> O man! hold thee on in courage of soul
> Through the stormy shades of thy worldly way—
>
> . . . . .
>
> Who telleth a tale of unspeaking death?
> Who lifteth the veil of what is to come?

HENRY E. ARMSTRONG

P.S.—On Friday evening (Jan. 22) I listened to an exquisitely clear exposition by Sir Wm. Bragg of his latest X-ray work. At the close, he spoke of quartz and demonstrated the development of an electric charge when the crystal is compressed or heated—attributing this to intramolecular displacements of the oxygen and silicon atoms. I have ventured to point out, that quartz is an electrolytic conductor of very high resistance—"so are we," say Stylo and Flannel—owing to the presence of traces of silicate. *Argal*: the effect may be simply one of frictional electricity

The Boskop Skull.

DR. BROOM's strictures in NATURE of December 19, 1925, on my paper on the Boskop skull, seem to call for some comment on my part.

I am charged, and I hold, unjustly, with inconsistency in regard to my suggested affinities of this "Proto-Bushman"; for my first reference to this theme is obviously expressed in general terms only. Merely in anticipation of what is presently to follow, I remark:—"A careful study of all the essential features of the skull of the Boskop man seems to show . . that he was a *derivative* of Cromagnon man (italics mine), and the progenitor of the Bushman."

With this brief forecast I leave the subject, of set purpose, as is shown by the continuation—"But before these relationships . . . can be profitably considered . . ." This anticipatory reference, then, can scarcely be interpreted as contradictory to the passage which follows on the next page:—

"The Proto-Bushman is supposed (in my Phylogenetic Tree) to have arisen out of the Neoanthropic 'flux' which was to give rise to . . . the Grimaldi people (and) the Cromagnards. . . ." Only by "quibbling" can these statements be considered as inconsistent, either with one another, or the "Tree" to which Dr. Broom refers.

In regard to the size of the brain of this skull, Dr. Broom remarks in his paper (published by the American Museum of Natural History), "If . . . we make a cast of the brain in plaster, and restore it into at least approximately its original condition, and then measure its size, *as I have done* (italics mine), I feel quite confident the capacity will be found to be more than 1900 c.c." This is highly probable. But I venture to doubt whether any anthropologist would "restore" the skull as Dr. Broom has done.

If we keep to the facts, to begin with, we shall start with a skull no more than 205 mm. in length and 150 mm. in breadth. There is not the slightest justification for Dr. Broom's measurements. In this I have the support of Dr. Haughton, who first described the skull. Having most carefully studied and measured this calvaria I am positive on this point.

I am also quite satisfied with the formula I used in estimating the cranial capacity; and this formula has the approval of no less an authority than Dr. Duckworth. In no test to which I have subjected it have I obtained a disagreement, as between it and other tests, of more than 30 c.c., which is a long way from the 200 c.c. cited by Dr. Broom.

Dr. Broom notes that I had a great deal to say "on the easy problem of the cranium." But if one may judge by his own efforts he has much underestimated this "easy problem." It is further noteworthy that Dr. Haughton, Prof. Elliot Smith, and Sir Arthur Keith have also attempted this task, and have each arrived at a different result. But this by the way.

Dr. Broom is deeply pained and surprised at my failure to realise the immense importance of the fragment of the lower jaw found with this calvaria. On this *alone*, according to his own statement, he decided that the Boskop man must be assigned the rank of a distinct species. This conclusion is curious. All of us who examined this fragment, while it was at the British Museum, regarded it as of no importance at all!

In Dr. Broom's paper he enters at great length into the problems which this fragment presented to him; and he arrives at some strange results. There is no need to discuss these at length. Suffice it to say that Dr. Haughton's interpretation of this fragment needs no amendment. He regarded its much worn stump of a tooth as answering to m. 2, and the remains of a socket enlarged by an abscess, as the socket of pm. 1. Dr. Broom, however, has convinced himself that this socket lodged the canine. Had he been more careful in his estimation of the distance between this socket and the remains of m. 2, he would have been less impressed by this fragment.

This jaw, however, even as restored by Dr. Broom, affords no warrant whatever for assigning to this skull the rank of a new species. Save that the teeth are unjustifiably spaced, it differs in no wise from that of a modern Bantu jaw. I can show him its counterpart. Properly restored, this jaw will resemble, much more nearly, that of a Bushman.

W. P. PYCRAFT.

British Museum (Natural History),
Cromwell Road, London, S.W.7.

Discharge of Electricity through Gases.

THE value of photographs of the Stark effect in the analysis of discharges through gases was emphasised by Prof. R. Whiddington in a recent review of the subject (NATURE, October 3, 1925, p. 506).

Discharge tubes of the type first used by Lo Surdo have a small diameter near the cathode. Owing to this fact an intense beam of light traverses Crookes' dark space, where high electric fields are developed. These fields are accurately determined from the Stark effect for any Balmer or other suitable spectral line.

Various field distributions in this interesting region have been reported by different investigators. Anderson found the field to be a maximum at the cathode surface and to decrease with distance therefrom in a nearly *linear* manner. Nyquist first observed a rapid *decrease* in the field *very close* to the cathode. Takamine's photographs show a rapid *increase* in the same region.

The last distribution is characteristic of the simplest tube of a few millimetres diameter with cathode fitted closely to the wall. Starting with this, I have repeatedly obtained first Anderson's (see Fig. 1) and then Nyquist's type by successive enlargements of the original tube very near the cathode. These modifications permit a broadening of the ionic stream with corresponding decrease in current density and field strength. Control of distribution is of some practical importance in the establishment of the highest electric fields obtainable with a given source of high potential.

As a correlating fact, it may be mentioned that when the Lo Surdo tubes I have used operated properly, they did not contain striations. Thus there is no conflict between Whiddington's interpretation of his experiments on striated discharges and the sharpness of Stark components. The sheets of positive ions which, in his opinion, fly through the tube at regular intervals, might be expected to have a very disturbing effect on the electric fields near the cathode. I have often observed well-defined striations in Lo Surdo tubes containing hydrogen and helium. The analysis at such times is quite useless from the point of view of the Stark effect. The blurred lines indicate the presence of weak and variable fields.

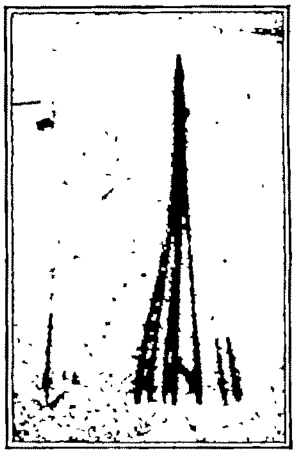

FIG. 1.—Perpendicular components of parhelium line group $\lambda 4144$ in electric fields (single prism spectrograph).

Normal Stark-Lo Surdo photographs, on the other hand, leave one with the impression that the field at a point in the Crookes' dark space can remain constant for hours. A careful examination for a Doppler effect showed that the parhelium atoms which emitted $\lambda 4144$ in Fig. 1 were not moving as a body toward the cathode with any appreciable velocity. These atoms were suspended, therefore, in a field which was probably due largely to neighbouring charges moving with relatively high velocities. Yet the width of each Stark component does not exceed that reasonably expected from the use of a wide slit, from imperfect focussing of the light on the slit, and from a few other disturbing factors.

J. STUART FOSTER.

McGill University,
Montreal, January 4.

The Study of Volcanic Activity on Vesuvius.

ON January 7 I had the good fortune to witness one phase of a minor eruption of Vesuvius in the company of Prof. Malladra, the distinguished director of the Vesuvian Observatory, and I shall be grateful if you will allow me the hospitality of your columns to direct the attention of all our younger geologists and mineralogists to the exceptionally favourable opportunities now presented by the mountain for the study of volcanic phenomena. The great crater left after the violent eruption of 1906 has been gradually filling up, and its floor is now within some 250 feet of the rim. On this floor stands an eruptive conelet, the apex of which is not far below the level of the rim of the 1906 crater, from which its explosions and ejections can be well observed.

The streams of lava which flow from time to time from fissures in the sides of the conelet, and by their successive outpourings are gradually raising the level of the crater floor, can be studied either from the same point of vantage, or else, at quite close quarters, after a scramble to the bottom of the crater by an easy path. On the floor of the crater there can also be studied the chemical changes produced in the lava by the action of hot gases forcing their way up from below, and typical specimens of the products can be readily collected.

These favourable conditions are likely to persist for the next two or three years at least. When, however, the 1906 crater has once been refilled, the activities of the mountain, though likely to become more awe-inspiring and formidable, will be less convenient for study than at present. Further, the presence in London of the admirable Johnston-Lavis Collection of Vesuvian specimens, maps and literature, now conveniently arranged and made accessible for study at University College, affords the English student a unique opportunity of making himself acquainted with the past history of the volcano, either before or after a visit to the locality itself.

In conclusion, it may be not out of place to mention that Messrs. Cook and Son, who work the Vesuvian railway, maintain a comfortable hotel immediately adjacent to the Observatory (Hotel Eremo), at which visitors who stay more than a day or two are received on very favourable "en pension" terms, and from which a large part of the mountain can be conveniently explored. ARTHUR HUTCHINSON.

The Mineralogical Laboratory,
Cambridge, January 25

The Mathematical Tripos.

IN his address to the Mathematical Association, Prof. G. H. Hardy urged the desirability of abolishing the mathematical tripos at Cambridge. May I direct attention to the disastrous results to which such a step might lead in other directions.

New universities are springing up all over England, and they are vying with each other in trying to give as many honours degrees as possible. These are purely examination qualifications, and the professor or lecturer teaching the students has generally no voice in the question as to whether the candidates are to pass or fail. These universities are frequently too poor to be able to keep more than one overworked professor and assistant, who know that unless they can get a good show of "firsts," or even honours people of any class, they will be looked on with disfavour by their colleagues.

No amount of "getting up" questions likely to be "set" or "doing papers" or "working examples and getting the right answer" or "revision" will, however, produce a mathematician, though it may and often does discourage someone that might become one. To my mind the essential requirement for the training of real mathematicians is that they should have followed discourses of lectures given by a large number of real mathematicians, each a specialist in a particular branch of the subject. In my Cambridge days I acquired my mathematical knowledge from about a dozen lecturers, and I am not sure whether the number of qualified lecturers in mathematics (good, bad, and indifferent) runs into two or three figures. I was one myself until I was forced to find employment elsewhere.

Apart from Cambridge there are very few universities possessing a sufficient mathematical staff to qualify any student for an appointment above the standard of an inferior schoolmaster.

If, however, the tripos were abolished, the Cambridge mathematical school would lose the best chance it has of attracting the degree seekers and trying to ram a little decent and intelligent teaching into their over-crammed brains. Personally I should be very sorry if the word "Tripos," which by usage has become the registered trade mark of the University of Cambridge, were abolished. It is in my opinion very unfortunate that they voluntarily surrendered an even more valuable proprietary name in the trade mark "Senior Wrangler" when it was in their power to use this designation as the brand of the best mathematicians of the year, when tested by any method whatever, including research work, even if this test is more or less covered by the Smith's prizes.

Therefore let Cambridge consider seriously before taking any step that will reduce its power of keeping students away from the honours examinations at cheap and nasty new universities. G. H. BRYAN.

Plâs Gwyn, Bangor,
Carnarvonshire.

Domestic Lighting and Heating.

IN the issue of NATURE of December 19, p. 910, an account is given of a house, where heating, cooking, hot water, lighting and power are obtained solely from electric energy. The yearly bill is something like 43*l*. for a ten-roomed house, and, considering that a judicious selection of the several agents available for lighting and heating would perform the same office for less than half the cost, with only very little labour as an offset, but with considerably more comfort, it may be asked where the advantage of the "all-by-electricity" system lies. "There is nothing to do but to operate a tumbler switch." When this has been said, apparently all has been said, for there is nothing tempting in the complicated and costly installation described in Prof. S. Parker Smith's paper, nor in the denial involved by the abolition of the open coal fire (with its appalling waste and its bright cheerfulness!) and of the direct open window ventilation, barred, evidently, by the small supply of heat which can be derived from an electric fire. Unfortunately, these two features, open coal fires and open windows, are essential features of British comfort and British health, and few would shirk the trouble of laying a coal fire with their own hands to spend a long evening by, if the alternative was the simple operation of a switch, and the resulting cheerless glow! I sincerely sympathise with any one who would follow the "simply-a-switch" lure and have but an electric fire to heat in winter a 14 × 22 feet room with a nice spacious window at each end admitting surreptitious draughts in proportion to the amount of light they let in.

The proper solution is not in the direction advocated by Prof. Parker Smith; it is in adjusting one's way of living with the view of a combination of maximum comfort, minimum labour and minimum cost. It is found in the use of a "living room" with an open coal fire (which burns but one scuttleful of coal a day, and, when desired, can be made to last all night, thereby saving the trouble of laying it in the morning). This fire does not require a special domestic servant, nor would its abolition enable one to be dispensed with. A "Sentry" boiler burning small coke (about 2*s*. 6*d*. per week) heats the kitchen and supplies hot water; it burns day and night for five or six weeks on end, requiring only a thorough raking morning and evening. The cooking is done by gas. In the warmer part of the year, hot water is obtained by means of geysers. The other rooms are heated by good gas fires which need but 15 to 20 minutes to bring an icy cold room 17 × 17 feet to a pleasant warmth. The lighting is done by electricity. The result is a comfort which it would not be possible to obtain with an all-electricity scheme. As to the yearly bill, in 1925 it was 18*l.* 11*s.* for a spacious ten-roomed house, this being divided as follows: coal 4*l.* 14*s.*, coke 3*l.* 16*s.* 6*d.*, gas 6*l.* 5*s.* 6*d.*, electricity 3*l.* 15*s.*; well under half the figure quoted by Prof. Parker Smith!

M. GHEURY DE BRAY.

40 Westmount Road,
Eltham Park, London, S.E.

Parthenogenesis in *Methoca ichneumonides* Latr.

IT is well known to collectors of Hymenoptera that the males of the Thynnid, *Methoca ichneumonides* Latr., are extremely rare, whereas the females are sometimes relatively abundant. Neither sex is common and the insect is described by Sharp as "very rare." It has been suggested that the males have been overlooked by collectors, that their life was short, and that their scarcity was only apparent. Recently I have been able to rear these insects in captivity, and my experiments show clearly that parthenogenesis does occur, a fact which readily explains the scarcity of the males.

In July 1924 I caught a number of females of this species near Woking and a single male at Oxshott. These females were provided with Cicindela larvæ, which they stung so as to paralyse them, and on which they afterwards oviposited in the usual way. From the eggs laid by these females a single female emerged in July of the following year. This female was provided with Cicindela larvæ and she was seen to oviposit, although she had never had access to a male In October 1925 I observed that five Methoca cocoons had developed from the ovipositions of this virgin female.

Although I was unable to observe any eggs on the Cicindela larvæ after oviposition by this female, owing to the position of the larvæ in their burrows, there can be no doubt that the cocoons were derived from the eggs laid by this female, and not from eggs aid on the larvæ before their capture. The Cicindela arvæ which I provided for the oviposition were all healthy, lively specimens, taken from open burrows, whereas it is well known that larvæ which have been parasitised by Methoca are very lethargic and incapable of co-ordinated movements of their appendages, he last pair of legs being totally paralysed. After oviposition the Methoca closes the mouth of the burrow of the larvæ, but all the larva I provided were taken only from open burrows.

It will be July 1926 before these cocoons produce magines, when I hope to be able to decide the sex f the inmates. I have opened one cocoon and found he inmate to be still in the larval condition. I hope o carry out further breeding experiments next year nd to obtain sufficient material for cytological work.

So far as I am aware this is the first recorded nstance of parthenogenesis in the solitary Vespoidea.

H. T. PAGDEN.

Christ's College, Cambridge,
January 13.

The Geological Congress and Museums.

THE *Compte rendu* of the Geological Congress held n Belgium in 1922 has just been received at the ritish Museum (Natural History). From it I learn hat there were made in the rules of organisation, reviously formulated in London, certain changes hat call for comment. An attempt, possibly unintentional, seems to have been made to restrict the vitations and the list of those competent to serve n the council to purely professional geologists presenting official surveys. But this was exposed and defeated by the restoration of at least the universities and geological societies to the list. Museums, however, were quite definitely in so many words eliminated from official representation. I beg to raise, and I hope to lead, an energetic protest against this slur on establishments that are a powerful means of promoting geology. Setting aside the Geological and Mineralogical Departments of the British Museum, which in the past have numbered men of rare and world-wide distinction among their officers, I may instance the American Museum of Natural History, the president of which is this year the recipient of the highest honour that the Geological Society of London can bestow, and the geologists and palæontologists of which have of late thrown light not merely on the past history of the Americas but of the Mongolian Desert.

Museums *qua* museums are, let us admit, no more deserving than certain bodies which bear the name of "University" or of "Geological Society." But every geologist will agree that there are many among them doing admirable work for his science. I am astonished that this indignity should have been proposed and supported by my friends E. de Margerie and R. W. Brock, men not wholly unfamiliar with the work of museums.

Perhaps I may explain that the personal question does not enter into this protest, since I can, in another capacity, take a seat on the council.

Circumstances no doubt conspired to render the Brussels Congress less representative of the geologists of the world than it might have been. We may, therefore, hope that this question will be taken up again at the International Geological Congress to be held at Madrid during the last week of May, and that on future occasions an official welcome will again be extended to delegates from the leading museums.

F. A. BATHER.

Department of Geology and Palæontology,
British Museum (Natural History).

Cirrus at a Lower Level than Alto-cumulus.

ON Sunday, January 24, at about 09·15, the sky was nearly covered with a sheet of alto-cumulus; this had a straight edge, there being quite clear sky low down in the east. In the northern and western parts of the sky and up to the zenith there were numerous streaks of cirrus uncinus, that is, cirrus streaks with the ends upturned; these were without a doubt below the alto-cumulus. All the clouds were moving from about north-west; the apparent motion of the cirrus was faster than that of the alto-cumulus. The upturned ends of the cirrus were to the southward, the streaks trailing away to the northward. The cirrus appeared dark against the clouds above it. The height of the alto-cumulus was measured with a range-finder. Three separate observations were made on different patches of cloud, at angular altitudes of 30°, 22°, and 20°; the heights obtained were 10,500 ft., 10,140 ft., and 10,260 ft. These are in very fair accordance, and there is, therefore, not much doubt that the height of the alto-cumulus sheet was between 10,000 and 10,500 feet; the cirrus must, therefore, have been lower, but how much lower it is impossible to say. The best development of the cirrus was at the time I have named, but some cirrus was seen below the alto-cumulus until about mid-day.

I have long been led to believe that cirrus may occur at a very much lower level than that usually given in text-books on meteorology, but I have never before come across such a very definite case.

C. J. P. CAVE.

Stoner Hill,
Petersfield.

The Sennar Dam and the Gezira Irrigation Project.

IN the Sudan, immediately south of Khartum, lies an extensive plain, known as the Gezira Plain, constituting the triangular tract of land enclosed between the two branches of the Nile—the White Nile and the Blue Nile, which unite at Khartum. Some fifteen or twenty years ago this area, comprising considerably more than 3,000,000 acres, was a barren waste. To-day, a substantial part of it is under cultivation and covered with crops.

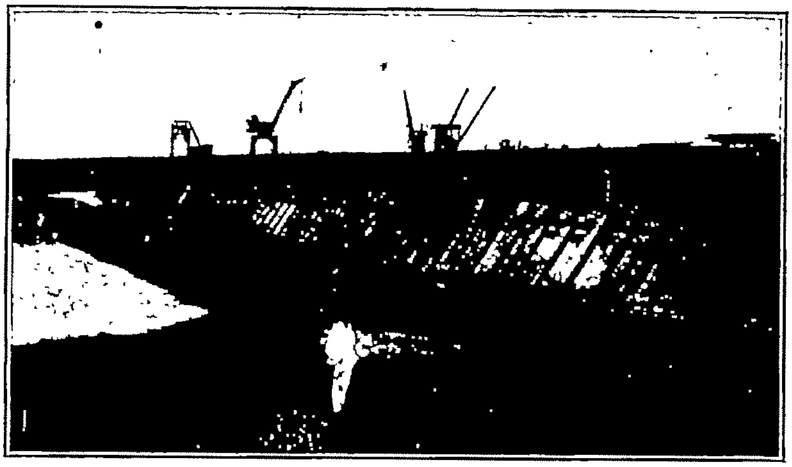

FIG. 1.—Sennar Dam. General view of the works taken from the downstream of the Dam on the west bank on May 1, 1925.

It was Sir William Garstin who, in recent years, first envisaged the idea of rendering this sterile tract cultivable. He put forward the suggestion at the beginning of the present century, and the possibilities of a system of artificial irrigation attracted favourable attention. After due consideration, the project ultimately materialised in accordance with plans prepared by Sir Murdoch Macdonald.

The scheme provided, in the first instance, for the construction of a dam across the Blue Nile at Makwar, a little village a few miles south of the more important town of Sennar. It was not, however, until 1913 that the necessary financial arrangements were completed, enabling the work to be begun in 1914. Suspended more or less during the War, operations were actively resumed thereafter, and the dam, as announced in NATURE of January 30, p. 167, was officially opened by Lord Lloyd on January 21, although the constructional work was actually completed last June, and the irrigation scheme has been in operation since the autumn.

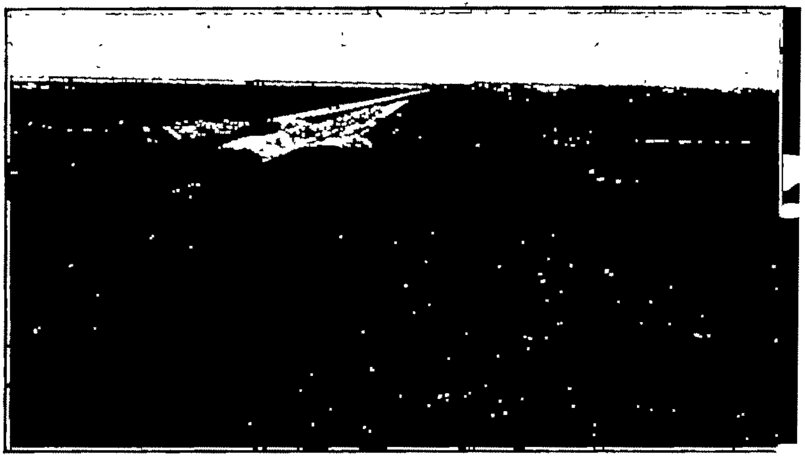

FIG. 2.—Gezira canalisation, March 10, 1925. View of main canal at Kilometre 80 from the Dam, showing a branch canal on the left, and on the right an area already developed and under cotton, and watered by pumps on the river.

Broadly speaking, it may be said that the area which has been canalised and rendered cultivable is equal to the county of Bedfordshire. The total length of main canals is about one thousand miles, and the length of the subsidiary canals is considerably greater. The surface soil is loess (black cotton soil), and the excavation was carried out by drag-line excavators.

The dam itself is an immense structure 3025 metres (nearly two miles) in length, built of granite rubble masonry, which has been founded on an outcrop of gabbro. It is substantially built and contains 422,440 cubic metres of stone and cement. The maximum height of the dam is 39·5 metres and the foundations are carried 10 or 12 metres down below the river bed. The central portion of the dam across the river channel, 1800 metres in length, is pierced by 80 sluices, each 8·4 metres high and 2 metres wide. Above this are 72 small spillways 2 metres high and 3 metres wide, while at each end of the sluice dam there are 20 large spillways, 5 metres wide and 2 metres high. The main canal head regulator, on the western bank, consists of fourteen sluices, 3 metres wide and 5 metres high. The Sudan Government Railway is laid across the dam, and is be extended at a later date so as to connect up wi the existing line at Kassala and so to communica with Port Sudan.

The reservoir formed by the dam is capable containing 636 million cubic metres of water, or, aft allowing for evaporation, 485 million cubic metres. In the cycle of seasonal flow, the reservoir will be filled during November, when the river is free from silt, and the impounding water will be used for irrigation from the middle of January to the middle of April. This reservoir will enable the whole of the natural supply of the upper Nile to be transmitted into Egyptian territory, only that portion of the water being retained in the Sudan for irrigation purposes which would otherwise pass off during flood into the Mediterranean. The present cultivable area lies at a distance of 57 kilometres from the dam and is served by a main canal, 114 kilometres in length. In the process of cultivation, crops will be grown in rotation. Of the 300,000 acres now irrigated, one-third will be assigned to cotton cultivation each year, and 100,000 acres to other crops, of which one-half will be maize, the staple food of the cultivator, and one-half lubia, a leguminous bean suitable for cattle fodder. The remaining 100,000 acres will lie fallow.

The full development of the scheme for the irrigation of the Gezira Plain involves the construction of another dam across the White Nile at Gebel Aulia, about thirty miles south of Khartum. The object of this dam, the construction of which is not yet commenced, is to ensure the summer water supply of Egypt.

The whole project is a remarkable manifestation of the benefits to be derived from the regularisation of forces of Nature, which in their unrestrained condition cause barrenness and waste, but when skilfully controlled add immeasurably to the resources at the disposal of mankind and bring comfort and prosperity in their train.

The consulting engineers for the scheme during the last two years have been Messrs. Coode, Fitzmaurice, Wilson, and Mitchell, who have courteously supplied the photographs reproduced herewith. The contractors were Messrs. S. Pearson and Son, Ltd., represented by Sir Frederick Hopkinson. The chief resident engineer for the Sudan Government was Mr. O. L. Prowde. The cost of the dam structure has been about 5,600,000*l*., or, including the canalisation works, 8,500,000*l*., but with preliminary expenses and other outlays the total cost of the project, so far, to the Sudan Government is in the neighbourhood of 13,000,000*l*.

Smokes as Aerial Colloids.

By Prof. R. WHYTLAW-GRAY.

CONSIDERING the rapid growth of colloid chemistry, it is remarkable that systems of finely divided matter suspended in gases have attracted so little attention from workers in pure science. This is all the more surprising because, on first consideration, such systems appear to be the simplest of all forms of disperse material, and it might be contended that just as the principles of the older chemistry originated from a study of gases, the investigation of aerial suspensions might throw a new light on the many complexities of the colloid state.

Apart from researches in physics which deal with the motions of individual particles mainly of microscopic dimensions, and centre around the question of unit electronic charge, much of the literature in this field is of an applied character, such as, for example, the cause and prevention of dust explosions in coal mines and factories, electrical precipitation, filtration, and settling, and the pathological effects of silicious and other dusts. Information on the stability of smokes, their electrical character and constitution, the size and nature of the aggregates formed on flocculation, is inadequate and meagre, so that the inquirer, unless he is prepared to make experiments himself, is perforce compelled to deduce the properties of these systems from first principles. This is the method followed by Dr. W. E. Gibbs in the very interesting survey of the subject delivered before the Chemical Engineering Group of the Society of Chemical Industry on October 9, and entitled "Aerosols in Industry."

From the literature available, Dr. Gibbs concludes that a close parallelism exists between these systems and the better known hydrosols. Thus smokes in general should owe their stability to the particles all carrying a charge of the same sign, and loss of charge should bring about flocculation or coagulation. The existence of an iso-electric point is assumed, and this it is stated can be reached by adsorption either of gaseous ions or of smoke particles of opposite electric sign. Stability is believed to be enhanced by adsorption from the medium of a protective gas sheath which diminishes the chance of adhesion or coalescence of the smoke particles on collision. It must be confessed that this is an attractive working hypothesis which is supported by the work of Rudge on the charges carried by dusts and also by many observations which have been recorded in the literature.

It seems but a step to go from aerosols to aerogels, and from protection to peptisation, and to assume, as the present writer did some years ago, that the counterpart of all the main characteristics of suspensoid colloids can be discovered in these aerial systems. This, indeed, may prove ultimately to be the case, but in the present state of our knowledge, more is to be gained from a study of the differences than by the pursuit of an analogy which is based on scanty experimental evidence.

Before this view can be tested, it is essential to be able to determine the degree of dispersion in aerosols and to trace how this varies under different experimental conditions. In the case of dusts, many methods are available for estimating the total weight of suspended matter and the number of particles in a given volume, but with the more highly disperse systems consisting mainly of units near the limit of the microscope, to which alone the term aerosol is really applicable, recourse must be had to the ultra-microscope and to special methods of filtration. An attempt along these lines has been made by the present writer and his colleagues. During the last few years a number of fine oxide smokes, composed of non-volatile materials, have been examined in some detail, and it has been shown conclusively that these differ sharply from hydrosols in two fundamental points at least.

(1) These smokes even when dilute are continually undergoing spontaneous aggregation. In contradistinction to the stable metallic sols, they are unstable coagulating systems. No exception to this behaviour has been found, and a non-coagulating aerosol, if capable of existence, has yet to be discovered.

(2) The charged particles in these smokes are never all of the same sign. Usually the oppositely charged units are present in equal numbers so that the smoke as a whole is neutral. Uncharged particles are invariably present and in some cases far outnumber the charged.

The aerosol, then, is not a stable suspension of the primary particles condensed from supersaturated vapour, but is largely a collection of aggregates of a wide range of complexity the proportions of which depend on how far coagulation has proceeded, *i.e.* on the age of the smoke. A corresponding condition in hydrosols is only found during the process of quick coagulation after the addition of an electrolyte.

Whilst the agitation of the particles under molecular bombardment brings them occasionally in close proximity, it is difficult to decide whether electric forces may not play an important part in rendering the collisions effective and so causing aggregation. Analogy may, however, be misleading, and so far no marked difference has been noticed in the rates of coagulation of slightly and highly charged smokes.

A quantitative study of coagulation from the point of view of Smoluchowski's theory is much easier to realise experimentally with aerosols than with hydrosols, for whilst with a gold sol of suitable dilution the process is completed in a few minutes, a dilute smoke alters comparatively slowly and permits the changes to be followed for several hours. It has been found possible, too, with these systems to estimate the size distribution at different periods, for not only does the brightness of the aggregate as seen in the field of the ultra-microscope increase with size, but the rate of fall increases also, so that the desired result can be attained either by a statistical classification of the particles by their brightness or their rates of fall, provided that these can be correlated with the radii with sufficient accuracy.

Now whether the radii calculated by means of the Stokes-Cunningham equation from the observed rates of fall are even approximately correct depends on the structure of the complexes. If these are compact and formed by the true coalescence of the primary units, the calculated radii will not be much in error even if the particles are irregular in shape and not truly spherical. If, however, the complexes or aggregates consist of units not actually in contact but separated from each other by minute interspaces filled with air, the mean density of the aggregate will be much smaller than that of the primary particles from which it is formed, and unless this is taken into account the radii deduced will be found to be much too small.

It is clearly necessary to know, to a first approximation at least, the mean densities of these composite particles. Millikan's oil drop method for determining the value of the unit electronic charge requires a knowledge of the density of the suspended droplet; conversely, the density of a suspended smoke particle, provided that it is roughly spherical in form, can be calculated from its rate of fall under gravity in conjunction with its rates of rise in a known electric field when carrying different charges. If the number of charges on the particles is known and the value of the unit charge is substituted in the equations, the mean density of a smoke complex can be deduced.

Considerations which cannot be discussed here make it probable that the rate of fall of these complexes is represented closely by the Stokes-Cunningham equation, provided the structure is not too loose and that the packing is close. Experiments along these lines have been made recently in my laboratory, and it appears that the composite particles in smokes of magnesium oxide, mercuric chloride, mercury and silver, possess densities varying from one-sixth to one-eleventh of that of the material in bulk, whilst coagulation in paraffin oil smoke gives particles of normal density, *i.e.* true coalescence takes place and homogeneous spheres are formed.

It seems probable, therefore, that any smoke formed by high temperature volatilisation must contain large numbers of these aggregates, and it is not surprising that the use of such particles by Ehrenhaft and others for finding the electronic charge should lead to erroneous values.

From the foregoing, it follows that the true radii of the majority of smoke particles are very much larger than has been supposed, and even in fine smokes usually exceed 3×10^{-5} cm., so that in many cases the supposed ultra-microscopic particles are really of microscopic dimensions. Recently, with a suitable optical system, it has been found possible to resolve these complexes when suspended in the air, and when this is done, the interesting fact emerges that the constituents, though closely joined together, are capable of independent Brownian motion. The smoke particle thus appears to be a system of primary units in dynamic equilibrium under the opposing forces of Brownian agitation and electrical or cohesional attraction.

It is probable that many of the properties of smokes can be explained by this structure of the complex aggregates, such as the low density of electrically precipitated smokes, and the fact that in some cases such material is peptised by weak acids or alkalies to form colloidal solutions as observed by Kohlschutter and Tuscher: the large amount of air carried down by zinc oxide fume and by carbon black pointed out by Gibbs; the immediate resolution of the large flocks of some smokes into their constituent particles on wetting; as well as the apparent stability consequent on their slow rate of diffusion and settling so marked in many fine industrial smokes.

Much work of a fundamental character is needed to elucidate the many aspects of these systems. Next to nothing is known definitely of the conditions under which ions are caught from the air and the particles acquire electric charges. The same may be said about the adsorption of gases by this type of finely divided material and also of its catalytic activity. Again, the investigation of systems composed of liquid droplets or of solid units of appreciable vapour pressure has scarcely been attempted. Indeed, the whole field of aerosols presents many interesting features and its further exploration is likely to yield results of much interest and importance.

Obituary.

Prof. Camillo Golgi.

PROF. CAMILLO GOLGI, member of the Italian Senate for a number of years, Nobel Prizeman in 1906, died on January 21. Though almost eighty-four years of age, he had preserved until a short time ago the astonishing lucidity of his marvellous mind, and when I saw him last in January 1924 he was still taking part in the public life of his country and scientific activities of the University of Pavia, where he had obtained his medical degree in 1865 and had become extraordinary professor of histology in 1875. Towards the end of that year he went as professor of anatomy to the University of Siena to return a few months afterwards to Pavia, where he occupied the chair of general pathology and histology until 1918, the year of his retirement from active teaching.

Son of a distinguished medical practitioner and for some time a pupil of Mantegazza, Bizzozzero and Lombroso, Golgi spent the first years of his career in the Home for Incurables of Abbiategrasso in the Province of Milan, where he went as chief resident physician. Abbiategrasso was in those days a village remote from any centre of scientific activity, and one can easily imagine how inadequate must have been the means of investigation with which young Golgi had to content himself. It was, however, in Abbiategrasso that he wrote his early papers on the history of pellagra, the etiology of mental alienations, the structure and development of Psammomata, the changes of the lymph-vessels of the brain and the structure of the neuroglia, which even now can be consulted with profit. But it was in that Hospital that he discovered his chromate of silver method by means of which nerve cells, with all their processes and the finest ramifications of the latter, can be seen singled out and intensely stained black against a transparent yellowish background. At a time when histological technique was in its infancy, and the structure of the central nervous system looked like an impenetrable mystery, Golgi's discovery revealed the existence of an unforeseen world. A first hint of the new method was given in his paper on the grey substance of the brain (1873). However, the so-called slow process was fully described only in 1875, and the bichromate and mercury chloride method in 1878. The rapid process was first published in his paper on the structure of medullated nerve-fibres (1880). All of them and the mixed process were again minutely described in the last chapter of his monumental work " Sulla fina anatomia degli organi centrali del sistema nervoso," published between 1882 and 1885.

By means of Golgi's methods the microscopic anatomy and physiology of the central nervous system were placed on the sound foundation on which they at present rest. He had since 1873 observed the long- and short-axoned nerve cells with which now every medical and science student is familiar, and the collaterals arising from the axon of the cells of the I type. Already in 1874 he had described the large nerve cells of the granule layer of the cortex cerebelli which bear his name, and pointed out that the "granules" are in fact minute nerve cells. In 1875 he had been able to give a first description of the structure of the olfactory bulb, and to show that both the olfactory fibres and the protoplasmic processes of the mitral cells arborise within the olfactory glomeruli. But it was only in his main work that he set forth definitely the results of his fundamental studies on the morphology and relations of nerve cells, the central origin of nerves, the architecture of some cerebral convolutions, the structure of the cortex cerebelli and hippocampal region, with the addition of fresh observations on the morphology, connexions with blood-vessels and histogenesis of neuroglia cells.

Golgi's description of the diffuse network (*rete nervosa diffusa*) was the anatomical corollary of these investigations and of those on the structure of the spinal cord (1880 and 1890). As he observed in various papers and again in his lecture at Stockholm, his diffuse network consists essentially of the collaterals of the axis-cylinder of the long-axoned cells, the complicated arborisations of the axis-cylinder of the short-axoned cells, and the collaterals and arborisations of the axis-cylinder of the motor and sensory nerve-fibres which reach any given region of the nervous system from others. He always considered the diffuse network, not as a working hypothesis, but as a well-defined anatomical entity linking together the different parts and functions of the nervous system. He was, however, extremely keen on pointing out that it is immaterial whether the thin filaments composing the network actually anastomose with one another or are simply superimposed to form thick interlacements. In other words, the continuity of the innumerable and non-insulated nerve-fibres which permeate the grey substance was in no way necessary to his conception of the united action of whole groups or layers of nerve cells or even entire regions of the central nervous system. For these reasons he persistently refuted the neurone theory, though based on the results of his methods, and could never agree to the individual action of nerve cells postulated by this doctrine.

Mention can only be made of other discoveries, such as the sensory end-organs of tendons (1880), the exact course of uriniferous tubules (1889), and the secretory canaliculi of the oxyntic cells of the gastric glands which Golgi succeeded in impregnating at the same time as Erik Müllar (1893). The pericellular investment and the internal apparatus of nerve cells were described in the same paper in 1898 and the neurofibrils of the superficial portions of nerve cells in 1900. In 1908 he published his arsenious acid method for the demonstration of the internal apparatus, and, by showing (1909) that this cell organ may in glandular epithelia become shifted from its ordinary position, he anticipated the results of recent investigations regarding the important part that the apparatus probably plays in secretion.

Of Golgi's researches in the field of pathology, it will suffice to recall his observations on malaria (1885–1893). After Laveran's discovery, Golgi gave a masterly description of the parasites of the tertian and quartan fever and their non-sexual cycle of development. By showing that the beginning of fever in malaria coincides with the sporulation phase, taking place at intervals definite for each species of the parasite, he led the way to the rational use of quinine in the struggle against this scourge of humanity.

C. Da Fano.

Mr. C. M. Doughty.

We regret to record the death on January 20 of Mr. Charles Montagu Doughty, the famous traveller in Arabia and poet, at Sissinghurst, Kent, at eighty-two years of age. Mr. Doughty was born on August 19, 1843, at Theberton, Suffolk. He was educated at Portsmouth, and later, on failing to enter the Navy, with which he was closely connected through his mother's family, he went to King's College, London, and Caius College, Cambridge. He took his degree, however, from Downing, to which he had migrated from Caius, obtaining second-class honours in natural science (geology) in 1865. During his career as an undergraduate he had shown a taste for antiquarian exploration, which he continued after taking his degree, spending some years in travelling and study. In 1866 he published a short pamphlet on the Jöstedal-Brae glaciers of Norway, where he had spent a year as an undergraduate. In 1870 he went to Holland, where he acquired Dutch and Danish, thence to Italy, Spain, and Greece, crossing over to Palestine a year later.

In 1876 Doughty began his journeys in Arabia upon which his reputation as a traveller and scholar chiefly depends, and for which he had prepared himself by familiar intercourse with the Arabs and expeditions to Egypt, the Sinaitic peninsula, and Petra. He had been attracted by accounts of Nabathæan and Himyaritic monuments at el-Hejr, near Medain Salih. Disguised, but not very successfully, as an Arab, under the name Halil, he set out with a pilgrim caravan from Damascus in 1876, and for nearly two years he was alone among free Arabs, living their life in the desert and in the oases. From the notes made by him the first chart of the superficial geology of the Arabian peninsula was compiled, and he first described the main hydrography of the northern half of the peninsula in communications to *Globus*; but he had become interested in the life of the people, and it is this side of his studies which gives the attraction and value to his great work, "Travels in Arabia Deserta," which was not published until 1888, and then only in a comparatively limited edition.

Partly owing to the fact that his interests were diverted into other channels, recognition of the great value of Doughty's work came late. In 1908 Oxford made him a Doctor of Letters, ***honoris causa***. A little later Caius College elected him an honorary fellow, and in 1920 his University of Cambridge gave him an honorary degree. In 1912 he received the gold medal of the Royal Geographical Society, and in 1922 he was elected an honorary fellow of the British Academy. It was, however, only during the War that his work came fully into its own, his book being made the chief guide and work of reference for our military and political staff operating in Arabia.

We regret to announce the following deaths:

Dr. Walter D. Hunter, chief of the section of insects affecting southern field crops of the Bureau of Entomology of the U.S. Department of Agriculture, who was known for his work on the cotton boll weevil, on October 13, aged forty-nine years.

Mr. B. N. Peach, F.R.S., formerly district geologist on H.M. Geological Survey, on January 29, aged eighty-three years.

News and Views.

An article on "Primitive Law and Order" by Dr. B. Malinowski, which appears as a Supplement to this issue of Nature, raises broad questions of vital interest to anthropological investigation and theory. Taking as his starting-point some of the social and economic activities of the natives of the Trobriand Islands, Dr. Malinowski has asked what is the binding force, the sanction, to use the legal phrase, responsible for their punctual and faithful performance. The conventional answer of current theory he finds by no means satisfactory. The communistic ideas which have been attributed to the Melanesians do not cover the facts. Dr. Malinowski has no difficulty in showing that the "communistic canoe" is, as a matter of fact, not communistic at all. Nor is any greater measure of reality to be attributed to the unquestioned obedience which primitive man is supposed to yield to custom backed by taboo and religious belief. Primitive man is no less unscrupulous than his civilised brother in evading his obligations if he can do so with impunity. Dr. Malinowski has put his finger on an inconsistency between theory and fact which has appealed to some, at least, both in the field and in the study. It has given rise to an uneasy feeling that an observer, not necessarily superficial, may have found by unconscious selection among the multifarious activities of the daily life of a primitive people, very much what he set out to seek. An apparently hasty conclusion has inevitably followed. Dr. Malinowski has attacked the problem by a new method and from a new point of view. He has taken certain concrete cases in primitive economics and social organisation and, by a searching analysis of the facts, shows that the conditions are such that no terms such as 'communism' or 'individualism' can be considered appropriate. The relations of individuals engaged in any economic or social activity depend upon a system of mutual obligations or reciprocities which might be regarded as something analogous to a system of 'civil' as opposed to 'criminal' law. Those who follow Dr. Malinowski's convincing argument can scarcely fail to endorse his plea for the application of his method and point of view to fields other than that in which he has employed them himself.

In 1885 a forest school for the training of the upper subordinate staff of the Indian Forest Service was established at Dehra Dun. In 1906 the Forest Research Institute was inaugurated during Lord Curzon's Viceroyalty. It was placed at Dehra Dun and the old school was given the status of a college, and courses were instituted for training members of the Provincial Forest Service. Research work proceeded slowly at first, since no accommodation was available. Grants were made and a fine Research Institute building was opened in 1913, it being considered at the time that ample accommodation had been provided for research for at least twenty years. The Institute grounds covered 47 acres, the land costing R. 1,68,000, and the buildings, including workshops, R. 5,08,000. The War period witnessed a great development. The forces on the eastern fronts had to depend mainly on India for their requirements in timber, fuel, fodder, and so forth. Great calls were made on the Institute, especially on the economic and utilisation side. By the end of the War, the Government of India recognised that the Institute had already outgrown the accommodation provided in 1913. A large project was accordingly drawn up. An area of 1300 acres was purchased a few miles outside Dehra Dun and plans for a new Institute building, laboratories, workshops, officers' quarters and offices were prepared, the new scheme being estimated to cost R. 1¼ crores.

THE most urgent need at Dehra Dun was for new economic laboratories for timber testing, impregnation, seasoning, paper pulp, etc., and for up-to-date machinery. These latter were all erected and at work before the close of 1924; one wing of the new Institute building was also under construction. To some extent the work was checked under recommendations of the Inchcape Retrenchment Committee, which considered that much of the research work could be left to private enterprise. Under the new Reforms Act, a certain section of Indian opinion wished to have the training of the probationers for the Imperial Forest Service carried out at Dehra Dun, and both the Legislative Assembly and the Council of State passed resolutions to this effect, so far at least as Indians were concerned. Under these proposals, the old Research Institute building was to be adapted for educational purposes. The *Times* of January 23 published a telegram from Delhi stating that the Finance Committee has sanctioned a sum of 833,000*l*. to be spent on the Research Institute. The wording of the telegram is somewhat ambiguous, but it appears to imply that the money has been granted for the development of both research and education in the above-described directions.

THE problem of checking cruelty to animals is one which particularly interests men of science, partly because cruelty is so often due to laxity of thought, and partly because the doctrine of evolution has discredited the view that animals are senseless automata and of importance only in so far as they affect man's welfare. Indeed, the fanatical hostility which Darwinism has encountered is largely attributable to an exaggerated contempt for them, and to consequent resentment at being connected with them by descent: it was, perhaps, not by coincidence that Charles Darwin and Russel Wallace were both earnest champions of the animals' cause. But if animals are far better off in Great Britain to-day than they were a hundred years ago, and than they still are in France, Italy, and most other countries, the improvement must be attributed largely to specific educational work such as that which has been fostered by the Royal Society for the Prevention of Cruelty to Animals. That work needs, however, to be extended, for we still meet with cruelty which arises, sometimes from vice, but more often from apathy and lack of imagination. A key to further extension appears to lie in the hands of university students, many of whom become teachers in after life, and accordingly an attempt is being made to provide machinery (in the University of London in the first instance) for directing the attention of students to the whole problem. To ventilate the proposal, the Students' Union of Birkbeck College is arranging a historical lecture on the subject on Friday, February 12, at 8.15 P.M., and at this, we understand, all readers of NATURE will be welcome. It is hoped that a large number of students and members of college staffs will support the attempt: they should send their names to Capt. C. W. Hume at Birkbeck College, London, E.C.4. We understand that the movement is already assured of the guidance of several experienced veterinary surgeons and biologists.

A WEEK or two ago a case of assault on an alleged witch, which came before a magistrate at Tipton, attracted no little attention; but the trial at Melun, in France, of a case of assault on a priest, is even more remarkable. Abbé Desnoyers of Bombon, the victim of the assault, was set upon and beaten by a party of men and women with the object of driving out the diabolic possession which had enabled him to interfere with the miraculous manifestations of an image of the Virgin, the object of a cult of which a Mme. Marie Mesmin, an illiterate former concierge of Bordeaux, was the head. The accused arrived at the court wearing black veils and spectacles, said to be as a protection against photography, but more probably as a protection against malevolent spells, as it was only with difficulty that they were persuaded to remove them while giving evidence. One of them identified the Abbé with Satan himself, and stated that he had sent diseases to Bordeaux by means of birds, by which he himself (the witness) had been affected, as well as Mme. Mesmin. He also said that the Abbé could inflict death on any one he liked within twenty-four hours, with or without suffering. He possessed dolls in which pins were stuck to injure his victims, and transmitted spells by birds. Mme. Mesmin had cried out between 12 and 2 o'clock in the morning, "The Abbé Desnoyers is killing me; get rid of him." It is interesting to note exactly the same accusations being made in the twentieth century as were made in the witchcraft trials in England and on the Continent in the sixteenth and seventeenth centuries. One of the prisoners said a priest sold to the devil was all-powerful. This was fully in accord with the remarkable frequency with which in France witchcraft has been connected with priests, the case of Grandier in the seventeenth century being, of course, the best-known instance.

"THE Arrival of Man in Scotland" was discussed by Dr. James Ritchie at the meeting of the Edinburgh and Lothians Branch of the Royal Anthropological Institute, held on January 19. Dr. Ritchie stated that the first men of whom evidence has been found reached Scotland at or shortly after the period of the 50-feet beach, when the sea stood at a considerably higher level than it does now, and the Firth of Forth penetrated inland far beyond Stirling. Along its margin in the Carse of Falkirk are many kitchen-middens, and in Oransay and a few other prehistoric settlements on the west coast, clear evidence has been found of the presence of a people of Azilian culture. They appear to have reached Scotland during a period of moist climate, perhaps some 9000 years ago. The Azilian men had no domestic animals and were unfamiliar with even the simplest agriculture. They lived solely by hunting and fishing, a large proportion of their food being made up of the common shell-fish of the sea-shore. They were sparsely scattered, probably never exceeding sixteen to the square mile. Vegetation was very similar to that of modern times except for the extensive forests and broad marshes. But many animals long extinct in Britain roamed in the forests or bred in the marshes or plains. Of the larger forest creatures, elk or moose, reindeer and the extinct wild ox or urus were common. The beasts of prey included the brown bear, the lynx (found only near Inchnadamph), and the wolf. Amongst smaller animals were the extinct northern vole, the lemming, and the beaver. Birds were represented by the great auk on the sea coast, by the forest capercailzie, the bittern, the crane, and the great bustard, all of which have since died out.

THE third annual meeting of British zoologists was held on January 9 in the rooms of the Zoological Society of London. Fifty-seven zoologists were present, and Prof. Graham Kerr occupied the chair. Among the more important contributions were the following: Dr. Bather referred to the importance of writers on zoological subjects following the generally accepted rules of zoological nomenclature and systematic work, and the view of the meeting was clearly that he should write a short paper to make the rules more readily accessible to workers. Prof. Stanley Gardiner spoke on the importance of entomology and moved "that this meeting of British zoologists, recognising the importance of entomology as a growing branch of zoology, both from a scientific and from a practical standpoint, urges greater provision in the British and other Museums and extended teaching and research facilities in the universities." This was carried unanimously, as was also a further resolution, "That this meeting of British zoologists represents to the Prime Minister and the Trustees of the British Museum the urgent need for an extension, both in space and in staff, of the Entomological Department of the British Museum." Prof. Douglas Laurie reported upon the progress towards the establishment of a diploma in zoology and also upon the progress of the library co-operation scheme. A discussion upon "the desirability of linking together the biological sciences," opened by Mr. C. Pantin, raised the question of the advances in modern zoological teaching and brought out views upon the physiological aspect as opposed to the morphological in the training of the student. The next meeting will be held on January 8, 1927.

THE *Times* of February 1 had an article on "The Rainfall of 1925," by Mr. R. Corless, superintendent, British Rainfall Organisation, Meteorological Office. The rainfall, as a whole, was only slightly above the average value, but the distribution of the fall presented some interesting and remarkable features. Over part of Hampshire, including the Isle of Wight, the year was the wettest since 1868 or before, but June was absolutely rainless. Other areas without rain in June included the western part of Cornwall and of Pembrokeshire, a tract at the head of the Bristol Channel, and several smaller areas on the south coast and in the Midland counties. At St. Martin's, Guernsey, it was the first rainless calendar month in an 82 years' record. Over England generally, the drought set in about May 30 and ended on July 1. A map is given showing the rainfall over the whole of the British Isles. The most striking feature of the map is said to be that the area in the south of England extending from Newhaven to Weymouth had an excess of the average for the year amounting in some cases to 40 per cent. At Ventnor the total fall was 41·25 in., and was the highest value since observations began in 1839, except for a total of 42·05 in. measured in 1852. The totals for Brighton and Yapton (near Littlehampton) were the largest ever recorded in 51 and 60 years respectively.

AT the meeting of the Illuminating Engineering Society on January 21, Mr. Eric Farmer, of the Industrial Fatigue Research Board, read a paper dealing with the lighting of coal mines, in the course of which he described experiments illustrating the benefit of screening the filaments of miners' lamps, preferably by a translucent coating on the inside of the protecting glass cylinder. Dr. H. S. Elworthy contributed data showing an apparent benefit, in cases of nystagmus, of a yellow-tinted glass, and for this several explanations were offered. It was suggested that this colour aids the miner in distinguishing bluish shale from black coal, that it is favourable to definition, and that the fact of the periphery of the retina being relatively insensitive to yellow light at low illuminations may help to check movements of the eyeball characteristic of nystagmus. There was a general recognition of the need for higher candle-powers, and a lamp operating with a 4-volt battery and yielding four times as much light as the ordinary lamp, though nearly twice the weight, was exhibited. The need for a standard specification for bulbs used in miners' lamps was pointed out, and it was emphasised that the demand for a life of 1000 hours is excessive for 2-v. lamps, resulting in a poor efficiency and feeble light Prof. Thornton, in a written contribution, suggested the possibility of ordinary methods of electric lighting in mines, based on the use of special cables fed by a low voltage high frequency alternating current, such as had already been found practicable for signalling purposes.

AT the anniversary meeting of the Royal Anthropological Institute held on January 26, the following officers for the ensuing year were elected: *President*, Mr. H. J. E. Peake; *Vice-Presidents*, Mr. C. O. Blagden, Prof. Percy Newberry, and Mr. R. W. Williamson; *Honorary Treasurer*, Dr. F. C. Shrubsall; *Honorary Secretary*, Mr. E. N. Fallaize; *Honorary Editor*, Mr. H. J. Braunholtz.

PROF. G. B. BROWN, Watson Gordon professor of fine arts, University of Edinburgh; Prof. A. S. Eddington, F.R.S., Plumian professor of astronomy, University of Cambridge; and Prof. T. Okey, professor of Italian, University of Cambridge, have been elected members of the Athenæum under the provisions of Rule II. of the Club, which empower the annual election by the committee of a certain number of "persons of distinguished eminence in science, literature, or the arts, or for public services."

IT was announced at the ordinary scientific meeting of the Chemical Society held on January 21 that the Council had received with sincere regret that afternoon the resignation of Dr. Arthur W. Crossley from the office of president, owing to ill-health. Prof. H. Brereton Baker has been nominated by the Council to the office of president. The annual general meeting of the Society will be held this year at Manchester on March 25, the annual general meeting being held in the University at 4 P.M., and the dinner in the Midland Hotel at 6.30 for 7 o'clock.

PROF. J. BARCROFT will deliver a lecture entitled "Hæmoglobin" before the Chemical Society on Thursday, February 11, at 8 P.M., in the Chemical Laboratory at University College, Gower Street, London, W.C.1. The lecture will be followed by demonstrations by Dr. Hartridge and Dr. Roughton, of a method of measurement of rapid velocity constants; by Dr. Keilin, of cytochrome in animal and vegetable tissues; by Prof. Barcroft and Dr. Hecht, of a method of measurement of equilibrium constants; by Mrs. Kerridge, of a glass electrode; by Mr. R. Hill, of porphyrins of the heavy metals; and by Mr. G. S. Adair, of measurements of osmotic pressure of hæmoglobin.

AT a meeting of the British Mycological Society held at University College, London, on January 23, Mr. Chaston Chapman dealt with the advantages to be gained by the foundation of a National Institute of Industrial Micro-biology, and the following resolution (proposed by Mr. F. T. Brooks and seconded by Prof. Dame Helen Gwynne-Vaughan) was put to the meeting and carried unanimously—"That the members of the British Mycological Society at their meeting held at University College, London, on January 23, 1926, are of the opinion that it is most desirable that a National Institute of Micro-biology should be established in this country."

DENMARK now possesses a sanctuary for the native fauna and flora, in an estate transferred to the University of Copenhagen, by the munificence of a private citizen. The property is that called "Strodam," near Hillerod, some 30 miles north of Copenhagen, and south of Elsinore. It comprises about 300 acres, and is to be a perpetual sanctuary for native animal and plant life to be preserved in the interest of natural science. The donor is Mr. Axel Jarl, whose family are well known for their munificence for any object of national benefit. Zoologists and botanists both of Denmark and other countries are indebted and will be grateful to Mr. Jarl for his practical if sentimental tribute to his native land.

ARRANGEMENTS are proceeding for the International Archæological Congress in Syria and Palestine which is to be held under the patronage of the two High Commissioners at Beirut in April next. Invitations have already been sent to a large number of representative bodies to appoint delegates to the Congress, and a revised programme of proceedings has now been issued. The work of the Congress will be arranged in three divisions, first ethnological and prehistoric, second ancient history, and third medieval and modern. Delegates are, however, asked to assemble in Jerusalem on April 2 for a special programme covering the week preceding the opening of the meeting at Beirut. It is hoped that they will be able to visit all the principal sites of archæological interest including Byblos, Sidon, Baalbek, Palmyra, Tiberias, Beisan, Megiddo, Jerusalem, and Jerash. After the close of the Congress on April 23, a visit will be paid to Petra, lasting from April 24 until April 28.

WE have received the third number of *Brighter Biochemistry*, the illustrated journal of the Biochemical Laboratory, Cambridge. It maintains the high standard of humour reached by its predecessors Although the topical allusions have mainly a local sign, yet any one who is acquainted with the work of this School can derive great enjoyment from them The illustrations both in the case of past and present personages are, we hope, rather legendary than actual portraits. In the section entitled "Dunnsday Boke" readers will find a full account of the manners and customs of the community. Copies, 2*s*. 6*d* each, may be obtained from the editors at the Sir William Dunn Institute of Biochemistry, Tennis Court Road, Cambridge.

THE first photographic lens interferometer, designed and made by Messrs. Adam Hilger, Ltd., and supplied to a British firm, is now installed at the Leicester works of Messrs. Taylor, Taylor and Hobson, Ltd., for the testing and control of their optical designs and products. The first problem which the research staff of the firm had to solve was to eliminate mechanical strains introduced by ordinary methods of mounting the component glasses. Such strains have been found in high-class anastigmats of all makes, and though slight in themselves, they introduce considerable want of symmetry in the interference patterns. The strains can be eliminated by a simple geometric mounting of the component lenses, for which Messrs. Taylor, Taylor and Hobson have applied for patent protection. The firm hopes to exhibit the system at the forthcoming Optical Convention.

MR. HERBERT SPENCER'S trustees are publishing through Messrs. Williams and Norgate, Ltd., an addition to Herbert Spencer's "Descriptive Sociology." The work, which will deal with Ancient Egypt, has been written by Sir Flinders Petrie and will be issued at an early date.

AMONG the spring announcements of the Cambridge University Press are "Science and the Modern World," by Dr. A. N. Whitehead, which embodies a study of the mentality of successive epochs during the past three centuries in so far as it has been influenced by the development of science; "The Quantum Theory of the Atom," by G. Birtwistle, dealing with the evolution of the quantum theory from its inception by Planck down to the most recent work on the reaction of the atom to radiation fields; and "Population Problems of the Age of Malthus," by G. Talbot Griffith, being a study of economic conditions and their effect on the birth, marriage, and death rates at the time when Malthus wrote his "Essay on Population."

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: Inspectors under the Ministry of Agriculture and Fisheries for the purposes of the Diseases of Animals Acts, 1894 to 1925—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (February 15). A tutor and lecturer on methods of teaching science (especially physics and chemistry) at the London Day Training College—The Principal, London Day Training College, Southampton Row, W.C.1 (February 22, on Form H.2/1). A Vice-Principal of the Somerset Farm Institute, Cannington, near Bridgwater—The Principal (February 22). A senior lecturer in the department of logic and metaphysics of the University of Glasgow—The Secretary, University Court, the University, Glasgow (February 24). A secretary to the Royal Horticultural Society—The Treasurer, Royal Horticultural Society, Vincent Square, S.W.1 (February 27). A man to take charge of the A.I.D. Chemical and Physical Testing Laboratory at the R.A.F. Stores Depot, Kidbrooke, S.E.—The Secretary (S.2), Air Ministry, Adastral House, Kingsway, W.C.2.

Our Astronomical Column.

RECENT SUNSPOT AND MAGNETIC "STORM."—On January 26, the largest magnetic disturbance for five years was recorded by the magnetographs at the Royal Observatory, Greenwich. The disturbance commenced at 16¼h., rose to a considerable maximum, and subsided soon after 5h. on the following morning. The greatest range shown during the disturbance by the magnetic needle recording magnetic Declination was one degree. The photographic traces of North Force and Vertical Force also showed considerable deflexions. Press telegrams announced a remarkable display of the aurora borealis seen from Norway and North America on the night of January 26.

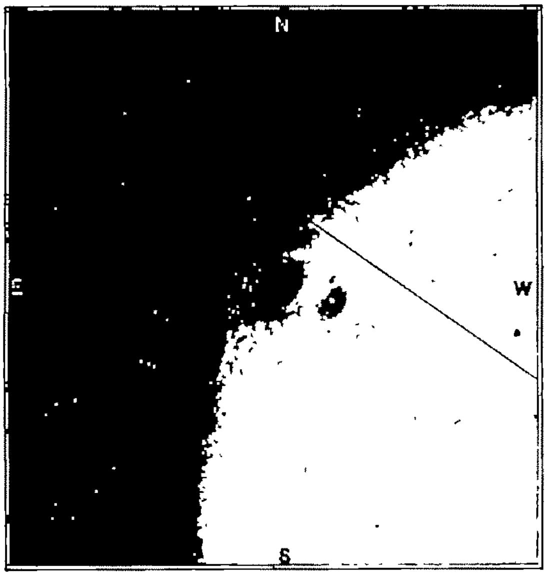

FIG 1.

At the time of commencement of the magnetic "storm," the great spot, which had been a prominent object on the sun's disc since January 18, was about 27° west of the central meridian. The spot was first seen from December 22 to January 3, when it was also of great size, but no disturbances of any consequence were recorded by the magnetographs during this period. Mr. J. Evershed, observing with his spectroscopic instruments at Ewhurst, Surrey, noted large disturbances in the chromosphere over the spot when seen close to the west limb on January 4 (R.A.S. report, *The Observatory*, February 1926).

The accompanying photograph (Fig. 1) was taken on January 20 at the Royal Observatory, Greenwich, and shows the large spot (latitude 22° N.) two days after its reappearance on the sun's disc. The spot is followed by bright faculæ in which a few scattered spots can be seen. Preceding the great spot by 9° of solar longitude is a smaller one, which has formed whilst this part of the sun was turned away from the earth. It is probably separate from the great spot disturbance, but the Mount Wilson polarity determinations will throw light on this point.

Details of position and area of the large spot will be found in NATURE of January 9 and 30.

PHOTOGRAPHIC STELLAR PHOTOMETRY.—The application of photography to stellar photometry has at present scarcely progressed beyond the experimental stage. Various methods have been used by different observers, and it is therefore of some interest to receive details of those in use at the Yerkes Observatory, as described by J. A. Parkhurst and Miss Farnsworth in the *Astrophysical Journal*, vol. 62, p. 179. The stellar images were taken in sharp focus, and were compared in a Hartmann microphotometer with an artificial scale of images, formed at equal intervals of about half a magnitude by giving a series of exposures, in logarithmic ratios, on a chosen star. The scale values were obtained independently on each plate by using coarse wire objective gratings, and comparing the first order spectra obtained in this manner with the central image. Both photographic and photovisual magnitudes were measured—the latter by using Cramer isochromatic plates with colour filters. The reduction to international magnitudes was effected either by means of duplicate exposures and comparison with stars of the North Polar Sequence, or indirectly by comparison with Harvard or Potsdam stars included on the same plate, reducing the latter magnitudes to photographic by correcting for colour index. The results of this work during 1914–1924, together with further details, are promised in a forthcoming publication of the Yerkes Observatory.

Research Items.

EARLY MAN IN RUSSIA.—In a recent number of the Russian *Anthropological Journal*, Prof. A. P. Pavlow, of Moscow, records the discovery of the fronto-parietal portion of two human skulls in a Pleistocene deposit near the village of Oundory, on the lower Volga. He describes them as in the same mineralised condition as the bones of the mammoth, woolly rhinoceros, reindeer, camel, and other Pleistocene mammals with which they were associated A human humerus, in the same state of preservation, was found with them. The brow-ridges in the skulls are not strongly marked, and Prof. Pavlow concludes that the new specimens may be referred to the same race as the skulls from Combe-Capelle, Brünn, and probably Prĕdmost He thinks the much-discussed skull from Galley Hill may be placed with them.

A CEREMONIAL "MASK" FROM NEW GUINEA.—In *Man* for January, Mr. T. A. Joyce figures a remarkable ceremonial object of indeterminate use from the Sepik River. It is here called a mask, a similar object having been described by Otto Reiche ("Ergebnisse der Südsee Expedition 1908–10," vol. 2, Pt. 1, p. 401) as the earliest form of mask, but no details as to its use were given. The present example has been presented, with other objects, to the British Museum by Mr. Schreibner of Dutch New Guinea. It shows no attachments suitable for a human head such as would be necessary for a mask. It resembles a shield, long-oval in shape, and is composed of basket work, of coiled technique, supported by a stout rim of split bamboo, and has a kind of "backbone" consisting of a wooden stick fastened to the reverse surface in a longitudinal section. The face is plastered with clay in which the ornamentation is set. At the top is a human skull secured by cane lashings, ornamented with cowrie shells, and furnished with a long artificial nose, similarly decorated. Below the skull are semicircular rows of shells and pigs' tusks simulating a necklace. The rest of the surface is decorated with series of pigs' tusks, coix seeds, crocodile teeth, fragments of shell, and two broken bits of china. The rarity of ethnographical specimens from the Sepik River gives these objects an exceptional interest.

THE REGIME OF THE NILE.—In a large and well-illustrated monograph on the Lake Plateau Basin of the Nile (Ministry of Public Works, Egypt, Physical Dept. Paper No. 21), Dr. H. E. Hurst makes some interesting additions to our knowledge of the origin of Nile water. From December to May the White Nile is the main source of Nile water, contributing in April so much as 80 per cent. In flood time, however, the Blue Nile may contribute so much as 72 per cent. and the Atbara so much as 26 per cent. Of the two streams of the White Nile, the Bahr el Gebel is more important than the Sobat. From early April to the middle of July the former supplies 50 per cent. of Nile water. Taking into account the time of travel of the water, it appears that the period of low water at Aswan, mentioned above, corresponds with November 8 to February 25 at Mongalla in the Sudan. Gauge measurements have shown that the contribution of the lake sources during that time is about 94 per cent. of the discharge of the Bahr el Gebel. The corresponding time at the tail of the swamps and the Sobat mouth is February 22 to June 11, when the discharge from the swamps is 73 per cent. of the total White Nile discharge. At Khartoum, where the critical period begins about a month later, the White Nile contributes about the same percentage of the total discharge. Hence Dr. Hurst calculates that during the period of water shortage in Egypt, nearly 50 per cent. comes from the equatorial lakes. This gives them a somewhat greater value to Egypt than was formerly accepted.

MOLLUSCA FROM THE MOLUCCAS.—A "Report on a Collection of recent Shells from Obi and Halmahera (Moluccas)" and surrounding islands, by Dr. C. H. Oostingh, has been published by the Geological Institute of the Agricultural University, at Wageningen (Communications, No. 9). It is a bulky list of just on 300 species almost exclusively marine, without descriptions, but with ample and properly compiled synonymy (which is rare) and distribution for each. It is further accompanied by an excellent and full bibliography giving the most recent information as to the dates of publication of the more important works cited Any one, therefore, working at the fauna of the region in question will find the work indispensable, whilst probably wishing that the little outline map of the Moluccas on p. 5 had been commensurate in value with the rest of the volume, and that an index to the genera had been added, since there is no hint given as to whose classification, if any one's, has been followed: it cannot be a very recent one since the pearl oyster has been left in the genus Pteria, from which it has long been removed.

CARIDEA IN THE INDIAN MUSEUM.—Dr. Stanley Kemp, in his concluding (seventeenth) note on Crustacea Decapoda in the Indian Museum (*Records Ind. Mus*, vol. 27, Pt. iv, 1925), brings together observations on members of eight families of Caridea, and provides synoptic tables, where necessary, of the characters of the genera and species. In addition to matters of taxonomic interest, the author directs attention to the occurrence in females of the genus Leptochela of dimorphism correlated with the breeding season. All the females with a tricarinate carapace were found to be either ovigerous or to have just liberated their young. The females with smooth carapace were not ovigerous, and showed no sign that they had recently borne eggs Dr. Kemp concludes that the female moults immediately before the extrusion of her ova, the carapace in the course of this moult developing longitudinal carinæ After the eggs have hatched, another moult occurs and the carapace resumes its original smooth condition. Dimorphic females have been found in three species, and it is not unlikely that they occur throughout the genus. The occurrence of luminous organs in two shallow-water genera of Pandalidæ is noteworthy, as such organs have hitherto been known among Caridea in deep-sea species belonging to the family Hoplophoridæ. The discovery of a species of Palæmonetes in a lagoon and in a backwater in south India is interesting, as no member of this genus was known between Mesopotamia and the coasts of China. Dr. Kemp suggests that the marked discontinuity in the distribution of the genus is more apparent than real, for this is an inconspicuous animal which will no doubt be found in many additional localities.

THE ORIGIN OF THE BANANA IN AMERICA.—The question of the original home of the banana has given rise to much difference of opinion, though most botanists have assumed that it lay in the Indo-Malayan region. It has been suggested that the banana was introduced into America by way of the Canary Islands and Hayti about the year 1516. However, a few early writers, such as Humboldt, have pointed out that it was cultivated along the Orinoco and Beni rivers by the aborigines at the time of their first exploration. There is, therefore, historical evidence that the banana was indigenous in America. Dr E. W. Berry has now been able to throw fresh light on the problem by the identification and description of fossil banana seeds from Tertiary beds in Colombia (*Am Journ Sci*, Dec 1925) The exact horizon cannot as yet be stated, but Dr Berry favours an Oligocene age The independent cultivation of the banana by the natives of America long before the advent of Europeans thus appears to be proved, though it cannot yet be argued that South America was the actual region of origin.

Parasitism of the Dodder.—At the present time when there is so much controversy on the rôle of xylem and phlœm in the transport of food in the plant, there is renewed interest in the method by which a total parasite like the dodder attaches itself to its host, as presumably this connexion must provide for the transport of food materials from host to parasite. Considerable interest therefore attaches to the conclusion reached by John Thomson (*Trans. of the Roy. Soc. of Edinburgh* 54, Part II No 5) that in the sucker of the dodder no phlœm whatever accompanies the xylem and penetrates into the host tissues. This conclusion is directly at variance with the earlier conclusions of Peirce and Thoday (Sykes) (*Annals of Botany* 1893 and 1911), but it is in complete agreement with a recent paper by Zender (Inst de Botanique, Université de Genève, Series 10 Fasc 8, 1924), and there seems little doubt that the earlier observers, who were not in agreement as to the position of the phlœm, were in error in reporting its presence. Thomson's further conclusion that the sucker makes little or no special attachment to the phlœm is surprising even for the one species he has examined, *Cuscuta reflexa* (Roxb), in view of the very special haustorial-like attachments to the phlœm described and figured by Zender in other species; but continental work on the anatomy of Cuscuta is somewhat neglected in Thomson's paper, and in the absence of any comparison of technique and results by the latter author, it is difficult to reconcile the discrepancies between the two accounts of the union between parasite and host.

Oxygen and Root Growth —*Publication No. 368* by the Carnegie Institution, upon the "Physiological Features of Roots," by William Austin Cannon, gives good reasons for introducing two new terms into the consideration of the oxygen relation of roots. The least oxygen partial pressure at which root growth is observed is termed the lower critical concentration and is valid only for a given species when growing at a given temperature, similarly an upper critical pressure is defined, which is the minimal oxygen pressure at which, at the given temperature, normal growth can take place. The oxygen demands of the root system increase very greatly with rising temperature, and while both these critical concentrations may be low for low temperature, at high temperatures the upper critical pressure in particular rises considerably. For many plants the range between upper and lower critical pressures may be very considerable, and represents a range, therefore, over which oxygen concentration is considerably limiting root activity. Whilst for some very aerobic root systems the higher critical concentration at high root temperatures may practically approximate to the normal oxygen content of the air, other root systems, like those of Salix and species of Baccharis, etc , may show a much lower upper critical concentration and continue to grow at very low oxygen concentration indeed. Another interesting feature of this monograph is a chapter contributed by Edward Elway Free upon experiments with small oxygen concentrations in which helium was used as an inert diluting gas to see if nitrogen could safely be treated as without action save as diluting the oxygen. At first experiments seemed to indicate that the nitrogen was more toxic than the helium to the root systems; this difference disappeared, however, when both gases were completely freed from oxygen, and it turned out that small oxygen concentrations seemed more readily available to the root system when the diluting gas was helium. This effect is traced with great possibility to the greater density of the nitrogen, which leads to the result that the small oxygen content is diffusing much more rapidly to the root surface through helium than through nitrogen.

Magnetite Garnet Rocks from Adelie Land — In the Scientific Reports of the Australian Antarctic Expedition (Series A, vol. 3, Geology, Pt. 5. Sydney, N S.W.: Alfred James Kent, 1925. Price 2s), A. L. Coulson describes a series of schists and gneisses collected from the glacial moraines of Cape Denison. The specimens are characterised by an abundance of either magnetite or garnet or both. About half of them—containing dominant magnetite—correspond closely with Grubenmann's Group XI. of the crystalline schists Others, however, contain garnet and magnetite in roughly similar proportions, together with quartz, felspar, and biotite, and their chemical characters are widely different from those of any group of schists hitherto defined It is suggested that these new types of garnet-magnetite rocks are probably derived from sediments the composition of which has been modified by igneous emanations. As the garnet is an aluminous variety, it seems probable that the original sediments were argillaceous, for in the analogous skarn-rocks of Scandinavia derived from limestones, the characteristic garnet is andradite That igneous emanations have played an important part in the development of the series is further suggested by the occurrence of a specimen containing abundant tourmaline This rock is also rich in cordierite containing well-formed pleochroic haloes, and its mineral assemblage indicates beyond doubt that it is a sedimentary derivative The petrological history of the whole assemblage of specimens has been clearly and convincingly elucidated, and the report is a valuable contribution to our growing knowledge of Antarctica.

The Measurement of Geological Time.—At the annual meeting of the Lake Superior Mining Institute on August 13 last, Prof. A. C. Lane presented the report of the Committee of the National Research Council on "The Measurement of Geological Age by Atomic Disintegration" Apart from the very careful work of Ellsworth in Canada, no very definite results have yet emerged, most of the active members being still engaged in developing methods. An example of one of the most promising of these is the concentration of the radioactive minerals, such as zircon and allanite, from a Palæozoic pegmatite near Boston. By a further concentration, allanite alone was separated, and its analysis by Ellsworth yielded a lead-ratio, Pb/(U + 0·354Th), of 0·043, a definitely Palæozoic ratio. Another new result is a ratio of 0·084 from an analysis of polycrase from Brazil by E. P Henderson. This agrees fairly well with results on presumably late pre-Cambrian minerals from Central Africa and Ceylon. The Committee has in hand further work which will enable an age comparison between Keweenawan and pre-Huronian granites to be drawn. It is pointed out that the most pressing needs are to test the hypothesis of Kirsch that thorium may be derived from "thorio-uranium," and to discover whether consistent lead-ratios can be obtained from minerals rich in thorium. The evidence at present available, and already discussed by Holmes and Lawson, does not support the Kirsch hypothesis, but suggests that thorium minerals tend to lose part of their lead just as all radioactive minerals necessarily lose part of their helium content. The Committee is to be congratulated on laying the foundations of this comprehensive research cautiously and securely. In its next report it should be able to clear up much of the present confusion of ideas due to the competition of conflicting hypotheses.

OPTICAL GLASS MANUFACTURE.—Interesting biographical details of Pierre Louis Guinand (1748–1824), who played an important part in the early development of the art of making optical glass, are given by M. Paul Ditisheim in the *Bulletin de la Société Astronomique de France*, April 1925. The advances in optical designing made by Moor Hall, by Dolland and by Ramsden had produced a demand for homogeneous pieces of flint glass of much larger size than had been previously required. The prolonged and laborious investigations of Guinand were largely responsible for enabling this demand eventually to be met. The methods he adopted are still considered essential in the present-day manufacture of optical glass. After developing his process at Les Brenets, in Switzerland, Guinand was engaged in 1805, by Reichenbach and Utzschneider, a firm of instrument-makers, to establish a glass factory at Benediktbeurn near Munich. Here he worked for just over eight years, producing glass for more than 5000 achromatic objectives. He worked in conjunction with Fraunhofer, whom he had instructed in the process of glass-making. Fraunhofer was put in charge of the works in 1811, and two years later Guinand returned to Les Brenets, where, with his son Aimé, he recommenced manufacture. In 1823 he placed at the disposal of the Astronomical Society of London a disk of flint glass of 7½ in. diameter. This was worked and mounted by Tulley, a London optician, and its performance called forth unstinted praise from Dolland, John Herschel and other members of the Society. Guinand died in 1824. In 1828 his son Henri, in partnership with G. Bontemps and others, introduced his processes into France. In 1848 Bontemps entered the service of Messrs. Chance Brothers of Birmingham, who were thus enabled to compete with the French firms, and have since then uninterruptedly continued the manufacture of optical glass.

A PHOTOGRAPHIC SPECTROPHOTOMETER FOR THE ULTRA-VIOLET.—A method of measuring the rotatory power of liquids for ultra-violet rays is described by Messrs. A. Cotton and R. Descamps in the *Comptes rendus Acad. Sci. Paris*, Jan. 4. Light which has passed through the polariser, a trough containing the liquid and the analyser, along an axis *xx*, is deflected at right angles to this axis by a train of prisms. It falls on a photographic film bent into a cyclindrical form with *xx* as the axis of the cylinder, forming upon it a series of images of a short slit for the different ultra-violet lines of the mercury arc lamp employed for illumination. The analyser and the train of prisms are mounted together, so that they form a system which can be rotated about the *xx* axis. The light spots move over the photographic plate, which registers their intensities for different positions of the analyser, making it possible to determine the angle at which each of them is extinguished. In the instrument as constructed, the first prism of the train also acts as the analyser, being made of Iceland spar; the second prism is of quartz, and the necessary lenses and the trough walls are transparent to ultra-violet rays.

BLACK AND WHITE GLOBULAR LIGHTNING.—In the *Comptes rendus Acad. Sci. Paris*, Jan. 4, M. E. Mathias collects accounts of a number of cases where non-incandescent bodies were seen to explode, in some cases causing injury or death. These balls of globular lightning were black, white or grey, and in the opinion of the author were due to a ball of ordinary globular lightning, the incandescence of which was hidden by a mantle of cloud or smoke, which in some cases clung to the surface of the ball, and in others formed a torn mantle around it. It is suggested that this smoke was due to the actual burning by the incandescent mass of organic substances such as cellulose. In one case, described by Zurche and Margollé, a number of luminous balls, and also grey balls, were seen to emerge from a waterspout or "tornado" at d'Arsonval (Pas-de-Calais), both kinds exploding with a loud detonation, sending out pieces of branches which the tornado had torn from the trees. The clinging mantle sometimes formed is ascribed to electrostatic attraction between the incandescent centre and the surrounding smoke.

DETERIORATION OF ALUMINIUM ALLOYS.—From time to time Prof. Ernest Wilson has communicated to the British Association the results of exposure tests made at King's College, London, on a series of light aluminium alloys in the London atmosphere. The experiments, which have been in progress for twenty-four years, are now brought together in a paper published in the *Journal of the Institution of Electrical Engineers* (No. 347). Aluminium alone, or alloyed with copper or with copper and manganese, shows a steady deterioration in electrical conductivity throughout the period, whilst the alloys containing copper and nickel, copper and zinc, or copper, nickel and zinc, often show a decided increase in conductivity after periods varying from five to ten years. The specimens kept in the laboratory for control also exhibit a small increase, and this process may be accelerated in the exposed specimens, or possibly the differential corrosion may have the effect of removing some of the impurities. The alloys containing copper and nickel are remarkable for their permanence, some of them being almost as good mechanically as when new. A microscopical examination would perhaps throw light on the nature of the changes which affect the conductivity, there being evidently a change of an internal kind which is distinct from the diminution of conductivity due to corrosion.

CONDUCTIVITIES OF HYDROGEN AND POTASSIUM CHLORIDE.—The *Journal of the Chemical Society* for December contains an account of the electrical conductivities of hydrogen chloride and potassium chloride in water and water-acetone mixtures, by T. K. Brownson and F. M. Cray. The measurements were made with great care and the results are of importance, since accurate work in the region of non-aqueous solvents is not too abundant. A minimum conductivity (equivalent) with hydrochloric acid was found with solvent containing 85 per cent. of acetone, and a minimum equivalent conductivity of potassium chloride was found with solvent containing 40 per cent. by volume of water. The Ostwald dilution law does not hold fully in any acetone-water mixture investigated, but as the acetone content increases it gives values more nearly approaching a constant at all dilutions.

Annual Report of the Smithsonian Institution.

THE annual report of the Secretary of the Smithsonian Institution, which was submitted to the recent meeting of the Board of Regents, revealed a wide range of activities for the year. The scientific expeditions in which the Institution took part penetrated into many corners of the earth. After researches extending over six years, Dr. Walcott discovered fossils in the Lyell limestones of the Canadian Rockies which fixed the limestones as of Upper Cambrian age. In China the Institution's zoological collecting expedition under the auspices of Dr. W. L. Abbott collected 50 boxes of insects, birds, mammals and reptiles, in spite of the murderous Bolotsi aborigines who infest the Province of Szechwan. Another expedition in China, under the direction of Mr. C. W. Bishop of the Freer Gallery of Art, Smithsonian Institution, examined a number of large mounds, including two tombs of the Han Dynasty (206 B.C. to A.D. 221). The work brought to light Chinese cultural objects dating from prehistoric times to the Han period, including stone axes, jade chisels, chariot fittings, mirrors.

In Panama and Costa Rica the Smithsonian botanical expedition under Mr. Paul C. Standley collected material for a report on the plant life of these little-known areas. Mr. John L. Baer, Smithsonian anthropologist, lost his life while with the Marsh expedition in Panama.

The Bureau of American Ethnology, which grew out of Smithsonian work begun in 1850 and is still directed by the Institution, conducted a number of important researches among the American Indians. The aboriginal Indian culture is fast disappearing, and every effort is made by the Bureau to secure as much as possible of this ancient lore before it is lost for ever. The Chief of the Bureau, Dr. J. Walter Fewkes, brought to light some rare copper ornaments while excavating mounds near Muscle Shoals, Alabama, which will be submerged when the Wilson Dam is completed. Dr. Fewkes also directed repair work on the tower of the famous "Mummy Cave House" in Arizona, one of the finest examples of primitive architecture in the south-west. Mr. J. P. Harrington continued his work of excavation of the Burton Mound Indian village, Santa Barbara, California. Large collections have resulted from his work, and Mr. Harrington is preparing for publication a monograph on the archæology of this interesting region. Miss Frances Densmore continued her researches in Indian music; the original phonograph records by means of which she obtained these songs from the Indians are preserved by the Bureau.

The year has been a most important one in the researches carried on by the Astrophysical Observatory of the Institution. Four papers were published during the year which summarise the work of the Observatory during the past twenty years on the sun's radiation and its connexion with weather on the earth. Experimental forecasts based solely on the variations in the solar radiation have been continued for the City of New York. These are still largely experimental, and the staff of the Observatory is now engaged in revising the methods of measuring and recording the sun's radiation. The observatory station on Mt. Harqua Hala, Arizona, has been removed to Table Mountain, California, to obtain better atmospheric conditions

The National Museum, another outgrowth of Smithsonian activities, which the Institution still directs, received during the year more than 350,000 new specimens. Among the most interesting of these were a series of slabs from the Grand Canyon containing a splendid series of fossil footprints; casts of certain of the famous finds of primitive man; and collections of California Indian baskets, insects from the late Colonel Thomas L. Casey, and mineral specimens, including axinite crystals, from Colonel Washington A. Roebling The Fukushima Company of New York has loaned for exhibition to the Museum a crystal ball weighing 110 pounds and measuring 13¼ inches in diameter, which is said to be the largest of its kind known.

The attendance at the National Zoological Park again exceeded all previous records, the total reaching 2,518,265 Mr Victor J. Evans made the outstanding gift of the year in a young male chimpanzee.

The report also directs attention to the urgent need of a suitable building to house the National Gallery of Art, which is now crowded in the National Museum to the detriment of the art and museum exhibitions. Congress has already provided a site in the Smithsonian park for a building, and through private subscription 10,000 dollars has been obtained for the preparation of preliminary plans.

The International Exchange Service, created by Secretary Joseph Henry, for the interchange of scientific and governmental documents with foreign nations and learned societies, handled during the year a total of 468,731 packages. A total of 2325 boxes of publications were sent to 64 foreign countries.

Owing to financial difficulties encountered by all international enterprises since the War, the International Catalogue of Scientific Literature, of which the Smithsonian administers the United States Regional Bureau, has not yet resumed publication of the seventeen annual volumes formerly published. Smithsonian publications reached a total of 155 volumes and pamphlets for the year. Of these the Institution proper published 68 items. The total of copies distributed reached 171,865.

In discussing his annual report, Dr. Walcott directed attention to the fact that the past year has marked a crisis in the financial affairs of the Institution. He pointed out the disparity between the extent and magnitude of the research and publishing activities of the Smithsonian Institution and its annual income of 65,000 dollars. Only 6000 dollars of this sum has been available for research and explorations, and the Institution has only been able to carry on the quantity of work done through the generosity of private individuals. In spite of this generosity, the Institution's publications have been reduced to a third of what they were before the War, and some series, such as the "Contributions to Knowledge," have been suspended altogether. Furthermore, the Institution has been unable to embark upon the larger projects in fundamental research which have been typical of its past history.

For these reasons the Institution has determined on several steps to increase its resources. One of these is to issue a series of popular scientific books to be known as the Smithsonian Scientific Series, similar in plan to the Chronicles of America series, issued by the Yale University Press. Another plan has been recently announced to the public in the nature of an appeal for an addition of 10,000,000 dollars to the Smithsonian's endowment. The decision to go before the American people has been made because of the fruitfulness of the original bequest of the Englishman, James Smithson, who founded the Smithsonian, because of the Institution's position as the pioneer of American research, because of the national scope of its activities and the national character of the benefits it confers in "the increase and diffusion of knowledge."

Research at the University of Sydney.

THE various centres engaged in productive scientific work are continually confronted with the problem of how best to bring the results to the notice of their colleagues. In chemical circles there seems to be a great effort made to confine publication, in the main, to certain well-known journals, to which all chemists will then naturally turn. So long as other channels exist for the chemical "cubist" to express himself in the possibility that he may be the conservative leader of the chemical theorists of the next generation, this is possibly a practical solution, at any rate for the countries where science is now well established.

Overseas universities and research centres frequently adopt the plan of issuing the work of their members, either as reprints from journals, or in local publications, and circulating this to other centres throughout the world with the view of receiving other publications in exchange. Such exchanges are probably growing in favour as a method of building up a library. The University of Sydney began thus to issue reprints in 1894, and in 1922 it much enlarged the scope of the scheme, deciding to issue these reprints in various sections dealing with different subjects. A number of these volumes has recently reached us, and though we cannot attempt a complete survey of their contents, we are glad to direct attention to a few of the valuable papers in them.

Series 6 is devoted to geological and geographical papers and vol. 1 includes twenty memoirs, by members of the staff and scholars of the University, mostly on the geology of New South Wales. The paper of most general interest is the lecture by Sir Edgeworth David on the antiquity of man in Australia, with special reference to the Tasmanians. He adopts the view that the Australians and Tasmanians come from different stocks, and in reference to the Talgai skull quotes Sir Arthur Keith's view that it is Tasmanian in affinity, though that view is not expressed in Sir Arthur Keith's last discussion of this skull. Prof. Griffith Taylor's presidential address to the Geographical and Historical section of the Australasian Association discusses the bearings of Australian geography on national problems, and adopts the conclusion that owing to the ethnologic superiority of the Chinese to the European, their entry and intermarriage with the Australians would improve the stock. Prof. Benson discusses the correlation of the Australian Carboniferous with the European, and remarks that the Burindi Series has some Viséan affinities. Prof L. A. Cotton describes the Kurrajong earthquake of August, 1919. Mr. W. R. Browne, in addition to a paper on igneous rocks in South Australia, gives a valuable account of the petrology of the country around the Broken Hill mining field. G. D Osborne and W. R. Browne describe a beautiful glacially striated pavement of Carboniferous age in New South Wales.

The first volume of Series 9 (Medical Sciences—Non-clinical) of the "Sydney University Reprints" consists of a number of papers most of which have appeared in various publications such as the *Journal of Anatomy*, the *Australian Medical Journal*, and the like. One, dealing with the diet of the Australians, by Dr. H. S. Halcro Wardlaw, is an official publication of the New South Wales Board of Trade. Dr. Wardlaw has also reprinted here a valuable paper on the energy consumption of Australian students. Among these contributions to science by members of the University of Sydney, which range in date from 1921 to 1924, we welcome several by the late Dr. J. I. Hunter, whose premature death has been a great loss to science; these include a study of a Neanderthoid Australian skull, written in conjunction with Mr. A. St. N. Burkitt, and a further contribution to the controversy on the relation of the Piltdown jaw and cranium, in which he reviewed Dr. Hrdlička's conclusions, which were largely based upon a study of the teeth, and gave a brief forecast of the results of the reconstruction at which he and Elliot Smith had arrived in their joint study of the cranium The paper on the Neanderthoid Australian skull mentioned above is worthy of special attention, as it is not so well known as it deserves. The skull was that of a female and showed a remarkable combination of primitive character in the cranium, combined with more delicate characters in the facial region, which was both orthognathic and leptorrhine. It had an enormous development of the supraciliary ridges, and glabella, a well-developed bregmatic eminence, and a marked development of the torus occipitalis. Added to these primitive features was an extremely low sloping forehead, while the maximum occipital point coincided with the inion. Certain features showed a resemblance to Pithecanthropus.

Vol. 1 of Series 12 (Social Science—Economics, Education, History, Philosophy, and Psychology) contains ten reprints, all short, varying from three to twenty-four pages, but there is no shame in brevity and these scholarly little articles are a valuable contribution to general philosophic and psychological knowledge Among so many varied papers it is difficult to make a selection for special note. Some of the articles are more descriptive, others more constructive, and high in the first category comes Prof. E. E. Anderson's stimulating account of "The Present Religious Situation"—a careful consideration of the nature of religious development. Sir John Macpherson's analysis of "The Influences which cause Fluctuations in the Production of Insanity" shows the enormous complexity of the subject, and the need for careful scrutiny of seemingly accurate statistics, and Prof. B. Muscio shows his characteristic originality and freedom from scholastic bias in his thoughtful contribution on "The Meaning of Philosophy." These reprints bear the same relation to the usual scientific treatise that a magazine of short stories bears to a novel, and, like a magazine, the volume is pleasantly readable

Vol. 1 of Series 13 consists of twenty-three papers published in various journals during the years 1920–1924 by workers in the Department of Zoology of the University of Sydney. The series includes the late Prof. W. A. Haswell's last two papers—on Astacocroton—a new type of acarid parasitic on the gills of crayfishes, and on the structure of the proboscis of the syllid worms, and two papers by Prof. L. Harrison on the breeding habits and the pigmentation of the eggs of some Australian frogs. Mr. E. A. Briggs, lecturer in zoology, contributes two papers, one of which describes in detail a new species of crawling medusa, and Miss E. E. Chase, demonstrator, gives an account of a new avian trematode. The two Macleay fellows of the Linnean Society of New South Wales, Miss M. Henry and Miss V. Irwin-Smith, are responsible for the remaining papers. Four by Miss Henry are contributions to a monograph of the fresh-water Entomostraca of New South Wales, and those by Miss Irwin-Smith are accounts of nematode worms, especially from lizards, and of the life-history of brachycerous Diptera. The Department of Zoology in Sydney has from its institution played a worthy part in scientific research, and the volume affords good evidence that no time was lost after the conclusion of the War in resuming investigations.

Vol. 1 of Series 2 contains botanical papers published between 1921 and 1924. To the botanists in a new country falls the duty of widening our horizon as to botanical conditions, and these papers are valuable examples of such literature. They include ecological studies of Australian vegetation by Marjorie I. Collins, of mangrove and salt marsh vegetation and arid and semi-arid regions; studies of Australian parasitic flowering plants, and of Australian examples of symbiosis (mycorhiza and root-nodules) by J. M'Luckie, also notes upon the life-history and structure of Australian Phanerogams and ferns by Prof. Lawson, P. Brough, and Jessie Steele. M. M. Williams has a brief note upon interesting brown seaweeds, including the one apparent parasite in the group, *Notheia anomala*.

Series 11 covers mathematics, physics, and astronomy, and vol. 1 contains seven papers dealing mainly with physical questions. They show that the University is not restricting its research work to the industrial problems which arise in the colony, but is taking its part in the solution of scientific questions the interest of which is world wide. Mr. E. H. Booth deals with the ions produced in air which has bubbled through water, a process which bears on the problem of how the earth maintains its negative charge. Dr. G. Harker shows that the vapour arising from a boiling solution has a temperature higher than that from the pure solvent boiling under the same conditions. Prof. Carslaw solves a problem on the cooling of a sphere with a core and shows that in the Mathematical Tripos of 1904 the candidates were asked to prove something which was untrue, while a paper by the late Prof. Pollock gives an interesting account of the physics of the stethoscope.

Vol. 1 of Series 3 is a collection of papers published in the various chemical journals by workers in the chemistry departments of the University. These show that research work is being actively prosecuted. Physical chemistry measurements include those of the molecular solution volumes of various organic substances in ethyl alcohol, which show that several of the solutes are associated in the liquid state; the development of the miscibility tests for eucalyptus oils in which the oils are added to methyl alcohol-water mixtures and the critical solution temperatures determined; the decrease in the values of the reaction constant in the decomposition of hydrogen peroxide by colloidal platinum when different concentrations of protective colloids are added, and the action of soaps as protective colloids for gold hydrosols, in which it is shown that although the stabilisation is very pronounced the coagulating influence of the sodium ion of the lower soaps begins to outweigh the protective action. A number of the reprints deal with organic chemistry: the preparation of organic compounds of arsenic of the type $R_1R_2R_3As$, $RAsI_2$ where R_1R_2, etc., indicate similar or dissimilar alkyl or aryl groups; studies in the formation of ring compounds by condensation of aromatic amines and diketones, etc.; researches on the phellandrenes and a number of contributions to the chemistry of piperitone. In addition, investigations have been carried out on the active principle of trees of the kind to which belong the dreaded "ordeal" or "doom tree" of the African pygmies.

Voltaire and Medicine.

In the second part[1] of his paper on "Voltaire and Medicine," read before the Section of the History of Medicine of the Royal Society of Medicine on December 16, the president, Dr. J. D. Rolleston, gave some account of Voltaire's allusions to anatomy and physiology, his advocacy of inoculation against small-pox, and his interest in the history and ravages of syphilis, a knowledge of which he had derived from Astruc's work on venereal diseases. He also referred to the attention paid by Voltaire to other matters connected with public health, his acquaintance with medical jurisprudence and particularly his sceptical attitude toward historical cases of poisoning, in many of which he showed that death was more probably due to some acute infection, and his remarks on various diseases of social importance, such as mental disorders, convulsive hysteria at the tombs of saints and ecclesiastics, alcoholism and the King's evil.

Several passages in his works show that Voltaire had paid some attention to anatomy. He commences his article on "Man" in the "Dictionnaire Philosophique" by saying that in order to learn the physical aspects of the human race, one must study works of anatomy or the article of M. Venel in the "Dictionnaire Encyclopédique," or rather follow a course of anatomy. In his article on "Anatomy" in the same work, he remarks that "Ancient anatomy bears to modern anatomy the same relation that the rough geographical charts of the sixteenth century do to the topographical maps of to-day." In the "Histoire du Docteur Akakia" Maupertuis is condemned for his advice to neglect anatomy. Voltaire, however, fully realised that much was yet learned in human anatomy. In Chap. 35, entitled "Incertitudes en Anatomie" of the essay "Des singularités de la nature," he exclaims, "In spite of all the help that the microscope has given anatomy, and in spite of the great discoveries of so many skilful surgeons and physicians, what interminable discussions have arisen, and in what uncertainty we still remain!"

Although physiology was still in its infancy in the eighteenth century, Voltaire seems to have been well abreast of the knowledge of his time. In the "Dictionnaire Philosophique" he alludes to the uncertainties current in connexion with circulation, digestion, generation, and muscular tonicity, and refers to the pioneer work of Borelli, Keil and Jurin in cardiac physiology. He exposes the errors of Descartes regarding digestion and circulation, and heaps ridicule on the casuist Sanchez and the philosopher Maupertuis for their extraordinary views on generation and embryology.

Voltaire's interest in public health was shown not only by his desire to control small-pox by inoculation, and syphilis by a league of nations to combat the disease—a project not realised until the formation of the Union internationale contre le péril vénérien in 1923—but also by his allusion to other epidemic diseases, especially plague and malaria, and his condemnation of the insanitary condition of the Paris hospitals, in which overcrowding and cross infection were rife. He also showed his concern for public health in his references to the abuses connected with the administration of military hospitals, the congested state of the Paris cemeteries and the practice of burial in churches, as well as by his proposal to found maternity hospitals for unmarried women.

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[1] See NATURE, December 19, 1925, p. 919.

University and Educational Intelligence.

CAMBRIDGE.—Plans have been prepared for the proposed building which is to house the Departments of Pathology and Animal Pathology. These are now exhibited. It is laid down that the total cost of designing, building, maintaining, and equipping the structure shall not exceed the sum of 115,000*l*., which is being provided by the Rockefeller Trustees (100,000*l*.) and the Development Commissioners (15,000*l*.). The proposed site is in the south-west corner of the area purchased from Downing College for the erection of the science schools.

DURHAM.—The Council of Armstrong College, Newcastle-on-Tyne, conferred the honorary title of reader in Genetic on Dr. J. W. H. Harrison, lecturer in zoology.

Mr. J. F. Duff has been appointed lecturer in education in succession to Mr. W. O. Brigstocke, who has received a similar appointment in the University of Liverpool. Dr. T. Iredale has been appointed lecturer in chemistry, in succession to Dr. V. G. Jolly, who has gone to an industrial post. Dr. Iredale is an Australian, and a graduate of the Universities of Sydney and London. Since 1921, when he first came to England, he has been carrying out research and demonstrating in chemistry in University College, London.

EDINBURGH.—Intimation has been received that His Majesty in Council has approved of Ordinance No. 142, Edinburgh No. 47 (Foundation of the Abercromby chair of archæology).

At a meeting on January 25, the Court agreed to take steps to commemorate in a suitable manner the two-hundredth anniversary of the institution of the Faculty of Medicine of the University, which will occur in the course of the present year.

Dr. and Mrs. Inglis Clark have presented to the Department of Chemistry a valuable quartz spectrograph and appurtenances in memory of their son Charles Inglis Clark, B.Sc., of the University of Edinburgh, who was killed in the War.

LONDON.—The following doctorates have been conferred: *D.Sc.* (*Botany*), on Miss V. M. Grubb (Bedford and Westfield Colleges) for a thesis entitled "The Spermatia of the Florideæ"; *D.Sc.* (Chemistry) on Mr. E. de B. Barnett (University College) for a thesis entitled "Action of Nitrogen Dioxide on Anthracene Derivatives and the Bearing on the Mechanism of Nuclear Substitution"; *D.Sc.* (*Chemistry*), on Mr. H. Phillips (Battersea Polytechnic) for a thesis entitled "The Optical Properties of *n*-Alkyl *p*-Toluenesulphinates"; *D.Sc.* (*Physics*), on Mr. E. P. Metcalfe (University College) for a thesis entitled "(1) On the Selective Absorption of Light by Luminous Gases and certain Consequences resulting therefrom, and (2) On Ionisation in various Gases"; *D.Sc.* (*Psychology*), on Mr. E. H. Magson (University College) for a thesis entitled "How we Judge Intelligence"; *D.Sc.* (*Cytology*), on Mr. R. J. Ludford for a thesis entitled "Studies in Normal and Pathological Cytology," and other papers.

Applications are invited for the Graham scholarship in pathology, value 300*l*. per year and tenable for two years. The latest date for the receipt of applications is February 28. Particulars can be obtained from the Academic Registrar, South Kensington, S.W.7.

MANCHESTER.—On January 20 Mr. W. H. Moberly, the Vice-Chancellor elect, was entertained at dinner by the teaching staff. More than a hundred members from all Faculties attended the dinner, which was held in the Refectory and was organised by the Association of University Teachers. The president, Prof. W. M. Calder, welcomed Mr. Moberly in a happy and informal speech, and the Vice-Chancellor elect in reply spoke of his pleasure at the reception he had received.

This function brought home to members of the University the fact that in a few short months Sir Henry Miers will be leaving, and the Faculty of Science will see his departure with great regret. The Science Departments are grateful to him as professor of crystallography for the active and invaluable department which he created. He has stimulated great interest in his subject, and graduate students have attended his lectures and laboratory with enthusiasm. The Departments of Physics, Chemistry, and Metallurgy owe much to his work, and it is hoped that it will be found possible to continue the department in some form.

Losses from death have been unusually heavy. Mr. James Grant, Dr. Edmund Knecht and Prof. William Myers of the Faculty of Technology, and Mr. C. B. Dewhurst, Clifton lecturer in engineering, all passed away last term, to the great sorrow of the University.

Dr. Henry Stephen, lecturer in chemistry, is leaving to take up the post of professor of organic chemistry at the University of the Witwatersrand, Johannesburg. Dr. G. N. Burkhardt has been appointed lecturer in chemistry.

Prof. F. E. Weiss, Harrison professor of botany in the University, has been elected an honorary member of the Botanical Society of Geneva.

APPLICATIONS are invited by the Battersea Polytechnic for Tate and Morgan scholarships in engineering, science, domestic science, hygiene, and art for the session 1926–27. The scholarships vary in value from 20*l*. to 30*l*. per annum with free tuition, and are tenable for two or three years. The latest day of entry is April 17 next. Full particulars are obtainable from the Principal.

AT the present time seventeen Ramsay Memorial Fellowships in chemical science are being held in the universities and colleges of the United Kingdom. The list of awards for the present session, with the institution selected by the fellow for his research, is as follows: *British Fellowships*, Mr. George A. Elliott (University College, London), Dr. H. Raymond Ing (Oxford), Dr. S. W. Saunders (University College, London); *Glasgow Fellowships*, Mr. James D. Fulton (since resigned), Mr. T. Corlett Mitchell (Cambridge); *Canadian Fellowship*, Dr. Donald McKay Morrison (Cambridge); *Danish Fellowship*, Mr. Kai J. Pedersen (Bristol); *Dutch Fellowship*, Mr. W. G. Burgers (Royal Institution, London); *French Fellowship*, M. Marcel Mathieu (Royal Institution, London); *Greek Fellowship*, Dr. N. Ekonomopoulos (University College, London); *Italian Fellowship*, Dr. Paolo Misciattelli (Oxford); *Japanese Fellowship*, Dr. Seisi Takagi (University College, London); *Norwegian Fellowship*, Mr. Leif Lindemann, 1924–25 (Sheffield), Mr. Karl Sandved (Imperial College of Science and Technology, London); *Spanish Fellowship*, Senor Fernando Calvet (Oxford); *Swedish Fellowship*, Mr. Erik Rudberg, 1924–25 (King's College, London), Mr. Gunnar Hagg (commencement of work deferred until October 1926); *Swiss Fellowship* (vacant during 1925–26). The total value of the annual amount of the fellowships that is awarded is approximately 4600*l*., of which about 3100*l*. is provided by grants from dominion and foreign sources.

Contemporary Birthdays.

February 1, 1843. Sir John Isaac Thornycroft, F.R.S.
February 5, 1866. Sir Arthur Keith, F.R.S.
February 6, 1860. Sir Archibald Denny, Bart., M.Inst.C.E.
February 6, 1835. Rev. Thomas R. R. Stebbing, F.R.S.
February 6, 1852. Dr. Conwy Lloyd Morgan, F.R.S.
February 7, 1877. Prof. Godfrey H. Hardy, F.R.S.
February 7, 1840. General Sir Charles Warren, G.C.M.G., F.R.S.
February 8, 1868. Lord Rothschild, F.R.S.
February 8, 1872. Sir Max Muspratt, Bart., M.Inst.C.E.
February 9, 1860. Sir Hugh Reid, Bart, M.Inst.C.E.
February 9, 1871. Prof. Edward C. C. Baly, C.B.E., F.R.S.

Sir John I. Thornycroft, naval architect and engineer, son of Thomas and Mary Thornycroft, both of whom were sculptors, was born at Rome. He was educated at a private school and at the University of Glasgow, coming there under the guidance of Sir William Thomson (Lord Kelvin) and Prof. Rankine. Setting up in business he founded the world-known firm established at Chiswick. Early in his career he designed and built the steam launch *Nautilus*, which proved a complete success. The *Lightning*, the first torpedo boat for the British Navy, was built at Chiswick; it was a pioneer in the design and construction of high-speed craft. Sir John also founded the extensive motor works located at Basingstoke. Here large numbers of motor lorries were constructed for war service, as well as high-speed motor boats.

Sir Arthur Keith, Hunterian professor in the Royal College of Surgeons, was born at Old Machar, Aberdeen. He was educated at Aberdeen, University College, London, and Leipzig. Author of many illuminating and critical contributions to anthropology, he was president of the Royal Anthropological Institute, 1912–14. A lecturer of distinction, Sir Arthur gave a noteworthy discourse before the Royal Society of Medicine in November last, on "The Nature of Man's Structural Imperfections."

Sir Archibald Denny, shipbuilder and marine engineer, of the firm of Messrs. William Denny, Bros., Ltd., Dumbarton, was educated, in the first instance at Dumbarton Academy, afterwards in Switzerland, later entering the Royal Naval College, Greenwich. It may be recalled that in 1877 the British Admiralty sanctioned the admission of one young constructive officer of the Imperial Japanese Navy as a student of naval architecture for two years at the Greenwich College. In 1879 a student of marine engineering was similarly sanctioned. Denny was at the College in 1879 with the first of these students—one Miyabara, who afterwards became an Admiral.

Rev. Thomas R. R. Stebbing, the distinguished zoologist, who celebrates his ninety-first birthday this week, and to whom we proffer our heartiest congratulations, is a Londoner, the fourth son of the Rev. Dr Henry Stebbing, F.R.S., who was acting editor of the *Athenæum* for many years after its foundation in 1828. Thomas Stebbing was educated at King's College School, London, and the University of Oxford. He was a tutor of Worcester College, Oxford, 1865–67, becoming an honorary fellow in 1908. Mr. Stebbing's zoological work has been concerned principally with the Crustacea. He carried to completion a monumental report upon the Amphipoda of the *Challenger* Expedition.

Dr. Lloyd Morgan, emeritus professor of psychology in the University of Bristol, was born in London. Educated at the Royal Grammar School, Guildford, he passed into the Royal College of Science, London. For a number of years he was a science lecturer in an institution in South Africa, returning in 1884 to take up the professorship of zoology and geology in University College, Bristol. Many interesting studies in biology and psychology have proceeded from his facile pen.

Prof. G. H. Hardy is Savilian professor of geometry in the University of Oxford (since 1919) Educated at Winchester, he graduated at Trinity College, Cambridge. He was Cayley Lecturer in the University, 1914–19. Prof. Hardy's recently delivered address as retiring president of the Mathematical Association, with its plea for the abolition of the Mathematical Tripos, has attracted considerable attention. He is a Royal medallist of the Royal Society.

General Sir Charles Warren celebrates his eighty-sixth birthday on Sunday, and we tender our very hearty congratulations. Educated at Cheltenham College, he passed into Sandhurst and Woolwich, entering the Royal Engineers in 1857. From 1867 to 1870 he conducted a series of excavations in Palestine, chiefly round the walls of the enclosure of the Temple of Jerusalem. The results of these early archæological studies were detailed in "Underground Jerusalem" (1876); "The Temple of the Tomb" (1880); and, in conjunction with Capt. Conder, "Jerusalem" (1884). Special Commissioner to settle the boundary of the Orange Free State (1876), he was deputed, in the following year, to arrange the land question which affected West Griqualand. Returning to England in 1880 he became instructor of surveying at Chatham. Sir Charles Warren's active military services are, of course, well known. They refer to Zululand, Bechuanaland, and Suakim.

Lord Rothschild has been for many years a trustee of the British Museum. Born in London, he was educated at Bonn and Magdalene College, Cambridge. Author of numerous works in zoology, Lord Rothschild has brought together large and valuable collections, which receive ample display and elucidation in his beautiful museum at Tring.

Sir Max Muspratt is well known in fields of industrial chemistry. Born at Liverpool, he was educated at Hemel Hempstead, Clifton College, and abroad. He entered the works of the United Alkali Co. in 1895, of which combine he has been successively director and chairman. Vice-president of the Federation of British Industries, he is chairman of the Association of British Chemical Manufacturers. Sir Max was Lord Mayor of Liverpool in 1917.

Sir Hugh Reid was born at Manchester. He was educated at the City High School, and graduated at the University of Glasgow. Managing Director of the North British Locomotive Co., Ltd., he is joint inventor of the Reid-Ramsay steam turbine electric locomotive. During the War he was a member of the Glasgow and West of Scotland Munitions Committee of Management. In 1917 he received the freedom of the City of Glasgow.

Prof. Edward C. C. Baly was educated at Templegrove School, Aldenham, and University College, London. From 1908 until 1910, he was assistant professor of chemistry and lecturer in spectroscopy at University College, leaving to become Grant professor of inorganic chemistry in the University of Liverpool.

Societies and Academies.

LONDON.

Royal Society, January 28.—A. C. **Seward**: The Cretaceous plant-bearing rocks of Western Greenland. The paper deals briefly with the geology of the localities visited, and, more fully, with the plants collected on the coasts of the Nûgssuak Peninsula and on the south-east coast of Disko Island. The fossils obtained include many species previously described by Heer. The Cretaceous plants are regarded as a single flora; Heer's threefold division (Kome, Atane, and Patoot series) is not accepted. Several species of ferns and gymnosperms, generally characteristic of the oldest Cretaceous floras and closely allied to Jurassic types, are found associated with representatives of Angiosperms that are strikingly modern. The Greenland Cretaceous flora seems to be Wealden-Cenomanian in age. It is considered that several deciduous dicotyledons were evolved in Arctic regions, where, in Cretaceous days as now, a short summer with continuous sunshine alternated with a long period of semi-darkness. From their Arctic home the flowering plants spread to the south.—W. L. **Balls** and H. A. **Hancock**: Measurements of the reversing spiral in cotton hairs. The spirals in the cell wall of cotton hairs may be dexter or sinister, and their reversals are apparently predetermined during growth in length. Genetic and ordinary environmental influences do not affect the statistical peculiarities of the reversals. The final adult length of the hair and the time taken in reaching that length do affect the reversal distribution. Nearly all the seed hairs of Gossypium begin to grow on a sinistral spiral. The angle of the helix varies around two modal values, but local variations are quite unaffected by inversion from dexter to sinister.—R. H. **Burne**: A contribution to the anatomy of the ductless glands and the lymphatic system of the angler fish (*Lophius Piscatorius*). The thymus body lies free beneath the mucous membrane of the pharynx, connected with the branchial cavity by a tube. This tube is not a duct, but more nearly resembles the crypts characteristic of the mammalian tonsil. The thyroid body is occupied by a large lymph sinus, into which lymph passes through valved openings from ventral and branchial lymphatics, and from which it is conveyed to the heart by the inferior jugular. Distributed to the mucous membrane of mouth and pharynx, and to the skin of the forepart of the body, is a system of "fine" vessels, similar in structure to small arteries. These vessels are not part of the blood vascular system, but connect by their terminal branches with the ordinary lymphatics. They are probably an afferent system of lymphatics.—I. **Gordon**: The development of the calcareous test of *Echinus miliaris*. All elements of the permanent skeleton which are laid down in the larva are traced back to a single spherical granule. This granule, with two exceptions, becomes a triradiate spicule even in the formation of a tetraradiate spine. The exceptions are in the development of (*a*) the base of a typical echinoid spine where it becomes hexagonal (a modification of the triradiate symmetry), and (*b*) the component parts of a tooth. The development of the tetraradiate spine, the simple and the compound tube-feet discs, and the blade of a pedicellaria is new. The large buccal plates arise interradially, and there are two sets of buccal tube-feet—(*a*) five primary ones with simple discs; (*b*) five secondary ones with compound discs, which are at first ordinary ambulatory tube-feet.—F. G. **Gregory** and L. **Batten**. A critical statistical study of experimental data on the effect of minute electric currents on the growth rate of the coleoptile of barley. A statistical analysis has been made of the data on which results described by Blackman, Legg, and Gregory for the effect of electrification on the growth of the coleoptiles of barley are based. Corrected data for the controls and four electrified sets show *positive* results, and, taken together, provide markedly significant evidence of the physiological effect of the discharge.—H. M. **Fox**: Chlorocruorin: a pigment allied to hæmoglobin. Chlorocruorin is a polychæte blood-pigment. It is red in concentrated, green in dilute, solution. It exists in oxidised and reduced forms, having spectra analogous to oxy- and reduced hæmoglobin. The oxygen affinity is less than that of hæmoglobin. Specific chlorocruorins differ in oxygen affinities; some are unsaturated at atmospheric pressure. Whereas hæmoglobin and a number of related pigments all contain the same hæmatin nucleus, chlorocruorin has a different hæmatin.

Geological Society, January 6.—W. N. **Edwards**: Fossil plants from the Nubian sandstone of Eastern Darfur. The plant-remains described were found by Mr. G. V. Colchester at Jebel Dirra, 75 kilometres east of El Fasher, in Darfur. They occur in highly silicified quartzitic sandstone, belonging to the Nubian Sandstone, and are the first fossils to be found in that formation in Darfur. The species identified, which probably grew in dune conditions, are *Weichselia reticulata* (Stokes and Webb), *Frenelopsis hoheneggeri* (Ettingshausen), *Dadoxylon ægyptiacum* Unger, and indeterminable fern-fragments. The beds in which they occur are thus assigned to the Lower Cretaceous, or possibly to the base of the Upper Cretaceous.—Vincent G. **Glenday** and John **Parkinson**: The geology of the Suk Hills (Kenya Colony). The Suk Hills lie in the northern part of Kenya Colony, midway between Mount Elgon and the southern half of Lake Rudolf. Sekerr, their highest point, reaches an elevation of nearly 11,000 feet. With insignificant exceptions, the rocks are of Eozoic age, and fall into two groups: a series of completely metamorphosed sediments, probably including ashes, and microcline-orthogneisses. The former group so closely resembles the Turoka series from the border of Tanganyika Territory that they cannot be separated, the whole being contemporaneous in general terms. The second group seems to be intrusive into the first.

PARIS.

Academy of Sciences, December 7.—A. **Lacroix** and Const. A. **Kténas**: The modern lavas of Fouqué Kameni (Santorin). A comparison of the complete analyses of lavas of different dates (1925, 1869, 1866, 1846) shows that the composition has remained almost unchanged.—André **Blondel**: The mechanics of the resonance of torsion of crank shafts.—M. Kamerlingh Onnes was elected a foreign associate in succession to the late Sir Archibald Geikie, and R. A. Millikan was elected correspondent for the section of physics in succession to the late Sir James Dewar.—— de **Séguier**: The divisors of the finite direct Abelian products.—— **Fatou**: A property of certain multiform analytical functions.—Armand de **Gramont**: A precision inverter permitting no articulated system.—R. **Chambaud**: The theory of thick circular arches.—D. **Riabouchinsky**: Some cases of irrotational movements in three dimensions.—Thomas Martin **Lowry** and Bawa Kartar **Singh**: The rotatory dispersion of nicotine. The results are given for three specimens of nicotine for 27 wave-lengths. The dispersion of nicotine was found to be simple.—Jean **Barbaudy**: The dehydration of aqueous alcohol by fractional distillation in the presence of benzene.—A. **Boutaric** and Mme. Y. **Manière**: The influence of the hydrogen ion concentration on the velocity of flocculation of some negative colloids.—P. **Vaillant**: The influence of an electrostatic charge on the superficial conductivity of a plate of rock salt.—P. **Lebeau** and A. **Damiens**: An easy method for the preparation of fluorine. As electrolyte the compound $KF \cdot 3HF$, melting at 56° C., is used. This is placed in a copper or nickel vessel, forming the negative electrode, the positive electrode being a nickel rod 8 mm. in diameter.—Marcel **Godchot** and Pierre **Bedos**: Monochlor-*o*-methylcyclohexanone.—I. **Pouget** and D. **Chouchak**: The radioactivity of the mineral waters of Hammam Meskoutine (Algeria).—N. A. **Critikos**: The seismic phenomena produced before and after the eruption of the volcano of Santorin.—M. **Bridel** and C. **Charaux**: The ferment extracted from the seeds of various species of Rhamnus or rhamnodiastase. Details are given for preparing this ferment from the seeds of *Rhamnus utilis*. It is of interest in that it produces a partial hydrolysis of glucosides, some of the glucoses remaining combined in the form of complex glucides.—Mme. H. **Gauthier-Lièvre**: Some observations on the algæ of Algeria in their relations with the *p*H.—L. **Plantefol**: The forms of growth of *Hypnum triquetrum*.—Raymond **Jacquot** and André **Mayer**: The equilibrium of the cellular constituents and the intensity of the oxidations of the cell. Imbibition and oxidations. The case of seeds.—René **Hazard** and L. J. **Mercier**: The action of the base tropine (tropanol) on the circulation.—P. **Reiss**: The development of the interior *p*H of the egg of the sea-urchin during fecundation and division.—Jules **Wolff** and Lucien **Grandchamp**: Some observations on the oxidisability of the iron contained in wine. The ferrous salts normally present in wine may be rapidly transformed into ferric salts under the influence of an oxydase, thus causing the phenomenon of *casse*.—L. C. **Maillard** and H. **Wunschendorff**: The formation of complexes between proteins and the hydrates of trivalent metals. The method of removing albumen by alums.—L. **Fournier** and P. **Mollaret**: The double hyposulphite of gold and sodium in the treatment of syphilis. The antisyphilitic action of this double salt is fairly energetic in large doses, but the general reactions and frequent skin troubles produced by the treatment present a serious obstacle to the use of this product in the treatment of human syphilis.—Stefan **Jellinek**: Death by electricity, practical results resulting from electropathological studies.

December 21.—L. **Lecornu**: Elastic transmissions. Reply to some criticisms by A. Blondel.—Maurice **Hamy**: The photography of stars in full daylight. An account of some results obtained by a method described in a previous communication. Photographs were taken at varying levels up to a maximum of 3274 metres. At this height, about midday, the extreme limit of photographic impression visible on the negatives, at 90° from the sun, was about the 6·5 magnitude.—A. **Desgrez** and J. **Meunier**: The mineral elements associated with oxyhæmoglobin from the blood of the horse. The metals were detected and roughly determined by the spectrograph. On the product from the first crystallisation, the hæmoglobin contains potassium, sodium, calcium, lithium, and minute traces of manganese. The second crystallisation reduces the marked preponderance of potassium without sensible variation of the calcium.—Félix **Mesnil**: The sensibility of trypanosomes of human origin to normal human serum.—Maurice de **Broglie** and Jean **Thibaud**: The total reflection and variation of the refractive index of the X-rays in the neighbourhood of an absorption discontinuity of the mirror. The measured values for the refractive index agreed within the limits of the experimental error with those calculated by the theory of Drude from the dispersion of electromagnetic waves. Thus the optical properties of the X-rays are identical with those of ordinary light and follow the same laws. This supports the undulatory character of the X-radiations, whilst their photo-electric phenomena bring out their corpuscular or quantic aspect.—Amé **Pictet** and Alfred **Georg**: New syntheses of isomaltose and gentiobose. Lævoglucosane is readily converted into dilævoglucosane, and the latter, by regulated hydrolysis with hydrochloric acid, gives a mixture of glucose and isomaltose. In the preparation of isomaltose by the condensation of glucose according to Fischer's method, there is formed a small quantity of gentiobiose.—E. **Mathias**: Contribution to the study of fulminating material: thermic heterogeneities. Discussion of the nature of ball lightning.—C. **Sauvageau**: The *bromuques* of Antithamnion. In a recent communication the author has indicated the presence of free bromine in the colourless refractive cells of *Antithamnionella sarniensis*, and has proposed the name of *bromuques* for these organs. Five species of Antithamnion, dried and pressed, have also been found to give the bromine reaction. Hence the *Blasenzellen* or gland-cells of Antithamnion act as organs for accumulating bromine.—René **Garnier**: A new method for solving the problem of Riemann.—Paul **Lévy**: The ratio between an integral series and its greatest term.—J. **Renaux**: A method of special perturbations.—Jean **Chazy**: The advance of the perihelion of Mercury.—Th. **Vautier**: The propagation of air waves produced by sparks or by percussion caps.—Mlle. Paule **Collet**: The constant paramagnetism of solutions: The atomic coefficient of magnetisation of chromium, whether deduced by the ascension method from a solution of potassium bichromate or from the attraction method using the solid salt, is the same.—Hippolyte **Copaux** and André **Copaux**: A method of estimating coloured gases, based on the use of the photo-electric cell, and its application to the case of nitrous vapours. The light, after passing through a column of the gas, falls on a photo-electric cell, and the deflexions of the galvanometer are plotted against the percentage of nitrogen peroxide. With gases containing between 0·2 and 0·7 per cent. of nitrogen peroxide, the latter can be determined with an accuracy of 0·02 per cent.—René **Dubrisay**: The application of capillary measurements to the study of mixtures of fatty acids. Measurement of the surface tension at the surface of separation of benzene solutions of mixtures of fatty acids and their alkaline aqueous solutions is shown to be a useful means of identifying certain acids and their mixtures.—A. **Kling** and A. **Lassieur**: The hydrogen exponent of water. In view of the fact that recent values for the *p*H of water range from 5·8 to 7·0, the authors have redetermined this constant with many precautions (distillations in platinum, no access of air containing carbon dioxide, etc.), finding for pure water *p*H = 5·8. This deviation from neutrality (*p*H = 7·07) may be attributed to the fact that water has a real acidity, or it may be that the current methods of measuring *p*H are faulty.—J. **Cournot** and K. **Sasagawa**: The variation with temperature of the resistance of ordinary mild and hard steels to shock by traction.—C. **Matignon** and J. **Cathala**: The action of phosgene upon glucina. The preparation of beryllium chloride The use of sulphur chloride for the preparation of anhydrous beryllium chloride, on account of the difficulty of separating the sulphur chloride, leads to an impure product. Carbonyl chloride, now a commercial product, gives good yields of anhydrous beryllium chloride, when passed over beryllium oxide heated to 1000° C. in quartz vessels.—**A. Raynaud**: The bromination of zinc in the presence of various organic solvents.—**A. Cornillot**: The constitution of the chloro-derivatives of the phthalonic series.—**Jacques Bourcart** and **M. E. Denaeyer**: The lithological characters of the lavas of Ahaggar, Central Sahara (Jacques Bourcart expedition, 1922–1923).—**R. Furon**: Geological observations on the Kabul valley (Afghanistan).—**Ch. Maurain** and **L. Eblé**: The propagation of seismic waves in limestone.—**Jean Lecarme**: The ultra-violet radiations of the sun at great altitudes. Using a method of measuring the intensity of the ultra-violet radiations depending on the decomposition of oxalic acid in the presence of uranyl sulphate as a catalyst, measurements have been carried out at various altitudes, the highest being at the Mont Blanc Observatory (4350 metres). It was noted during these experiments that whilst the solar radiation produced a rapid decomposition of the oxalic acid, the effects due to the light of the mercury arc were scarcely sensible. From this it would appear that the solar ultra-violet energy is greater than that of the ordinary mercury arc, although the biological effects are less intense.—**O. Munerati**: Is there an after-ripening in recently plucked cereals?—**Ch. Killian**: Observations on the postembryonic development of *Drosera rotundifolia*.—Mlle. **Panca Eftimiou**: On *Exoascus deformans*.—**Lucien Daniel**: Heredity in *Helianthus tuberosus Dangeardi*.—**Em. André**. Contribution to the study of the oils of the chaulmoogra group. The oils of seven different Flacourtiaceæ, each regarded in the country of origin as possessing curative properties against leprosy, have been extracted and their chemical and physical constants determined. These possess one character in common, the deviation to the right of the plane of polarised light.—**Marcel Baudouin**: Radiographs for the diagnosis of the nature of the human work executed on the teeth in ethnography.—**R. Bonnet**: The influence of variations of external temperature on the magnitude of the specific dynamic action in the Poikilotherms.—**André Mayer** and **L. Plantefol**: The influence of the electrolytes of the medium on the gaseous exchanges of the mosses.—**E. Fauré-Fremiet** and **Robert Wallich**: A physical factor of cellular movement during the cultures of tissues *in vitro*.—**A. Dorier**: The faculty of encystment in water of the larva of *Gordius aquaticus*.—**L. Rapkine** and **M. Prenant**: The reaction of the blastocœlian liquid in the pluteus of the sea urchin in the first phase of development.—**Lucien Cavel**: The nitrogen losses in the purification of sewage by the method of activated sludge.—**G. Mouriquand** and **M. Bernheim**: New researches on the relations between age and the appearance of troubles of avitaminosis C.

Official Publications Received.

Wisconsin Geological and Natural History Survey. Bulletin No. 65. Educational Series No. 8: The Geography of Southwestern Wisconsin, By W. O. Blanchard. Pp. viii+117. Bulletin No. 66, Economic Series No. 22: Limestones and Marls of Wisconsin By Edward Steidtmann; with a Chapter on the Economic Possibilities of Manufacturing Cement in Wisconsin, by W. O. Hotchkiss and H. F. Bean. Pp. x+206+6 plates. Bulletin No. 67, Educational Series No 9: A Brief Outline of the Geology, Physical Geography, Geography and Industries of Wisconsin. By W. O. Hotchkiss and H. F. Bean. Pp. iv+60. (Madison, Wis.)

Notas geofisicas y meteorologicas publicadas por el Observatorio Nacional de San Bartolomé de Bogotá. Numero 2: Los Huracanes de las Antillas. Por Rev. Simon Sarasola. Pp. vii + 172. (Bogotá, Colombia)

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 8, No. 5: Nitrogen Recuperation in the Soils of the Bombay Deccan, Part I. By D. L. Sahasrabuddhe and J. A. Daji. Pp. 53-68. (Calcutta: Government of India Central Publication Branch.) 4 annas; 5d.

Journal of the Royal Society of Western Australia. Vol. 11, 1924–1925. Pp. xii+163+iii. (Perth.) 21s.

Institut de France: Académie des Sciences. Annuaire pour 1926. Pp. 380. (Paris: Gauthier-Villars et Cie.)

Bulletin of the National Research Council. Vol. 10, Part 3, No. 53: Transactions of the American Geophysical Union, Sixth Annual Meeting, April 30 and May 1, 1925, Washington, D.C. Pp. 80. (Washington, D.C.: National Academy of Sciences.) 1 dollar.

International Geodetic and Geophysical Union (Union géodésique et géophysique internationale): Section of Terrestrial Magnetism and Electricity. Bulletin No. 5: Transactions of Madrid Meeting, October 1924. Edited by Louis A. Bauer. Pp. viii+180. (Baltimore, Md: Johns Hopkins Press.) 3.50 dollars.

Commonwealth of Australia: Institute of Science and Industry Bulletin No. 29: Natural Enemies of Prickly Pear and their Introduction into Australia. By W. B. Alexander. Pp. 80+13 plates. (Melbourne: H. J. Green.)

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 77: Anatomy of Hendersonia, a Primitive Helicinid Mollusk. By H. Burrington Baker. Pp. 273-303+plates 7-10. (Philadelphia.)

Union of South Africa: Department of Agriculture. Reprint No. 4, 1925: Weeds of South Africa, Part 3. By K. A. Lansdell. Pp. 34+5 plates. (Pretoria: Government Printing and Stationery Office.) 3*d*.

The Welsh Journal of Agriculture: the Journal of the Welsh Agricultural Education Conference. Vol. 2. Pp. 303+9 plates. (Cardiff: University of Wales Press.) 1*s*. 6*d*.

Diary of Societies.

SATURDAY, February 6.

Royal Society of Medicine (Otology Section), at 10.30 A.M.—Dr. D. McKenzie: Report on a Case of Temporo-sphenoidal Abscess.—F. W. Watkyn-Thomas: Report on a Case of Necrosis of the Petrous Bone.

Association of Women Science Teachers (Annual General Meeting) (at St Paul's Girls' School), at 10.30 A.M.—Educational Films, chiefly Scientific, shown by the Visual Education Society.—At 2.30.—Miss Coward: The Teaching of Hygiene in Schools; Short Papers on the same subject.

Society of Chemical Industry (South Wales Section) (jointly with Institute of Chemistry and Wales and Monmouthshire Junior Gas Association) (at University College, Singleton Park, Swansea), at 2.30.—C. A. Seyler: The Microscopy of Coal.

Royal Institution of Great Britain, at 3.—Sir Walford Davies: The Triad and the Perfect Fourth (1).

Gilbert White Fellowship (at 6 Queen Square, W.C.1), at 3.—Miss L. E. Cheesman: Insect Collecting in the Society Islands.

Institute of British Foundrymen (Lancashire Branch) (at Grand Hotel, Manchester), at 4.—J. G. Robinson: A Day in the Foundry (Lecture).

Hull Association of Engineers (at Technical College, Hull), at 7.15.—Fuel Oil and its Applications (Lecture).

MONDAY, February 8.

Royal Irish Academy, at 4.15.

Biochemical Society (at Lister Institute), at 4.30.—H. Chick: Sources of Error in the Biological Method of Investigating Fat-soluble Vitamins.—P. Hirsch: The Serum Diagnosis of Malignant Growths with the Interferometer.—P. C Raiment: The Oxidation of Uric Acid with Hydrogen Peroxide.—L. S. Maclean and D. Hoffert: The Synthesis of Fat by the Living Organism.—N. Wright: The Action of Hypochlorites on Amino Acids and Proteins.—R. H. Marriott: The Action of Sodium Sulphide on Hair.

Royal Society of Edinburgh, at 4.30.—Prof. H. Briggs: The Wheatstone Bridge as the Means of Measuring Linear and Angular Dimensions at a Distance, and its Application to Borehole Surveying.—Prof. E. T. Whittaker: On the Adjustment of Sir J. J. Thomson's Theory of Light to the Classical Electro-magnetic Theory.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—Prof. F. F. Roget: A Philosophic Exponent of Latin Culture, Alexandre Vinet: Protestant Divine and Literary Critic (1797–1847).

Royal Society of Medicine (War Section) (at Central Medical Board, Royal Air Force, 3 and 4 Clement's Inn), at 5.—Demonstration: The Medical Examination of Candidates for Aviation, with Particular Reference to the Physiological and Ophthalmological Tests Employed.

Royal College of Surgeons of England, at 5.—Prof. A. Tudor Edwards: The Surgical Treatment of Phthisis and Bronchiectasis.

British Institute of Philosophical Studies (at Bedford College for Women), at 5.30.—Prof. J. Johnstone: Failure of Mechanistic Conceptions of Life: Neo-vitalism.

Institution of Structural Engineers (Students' Meeting), at 6.—H. K. Dyson and others: Discussion.

Institution of Automobile Engineers (Birmingham Centre) (at Chamber of Commerce, Birmingham), at 7.—T. D. Carpenter: Modern Chassis Frame Design and Body Mounting.

Institution of Electrical Engineers (Informal Meeting), at 7.—R. J. Mitchell and others: Discussion on Modern Applications of Ball and Roller Bearings.

Institution of Electrical Engineers (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Prof. S. P. Smith: An All-Electric House.

Institution of Mechanical Engineers (Graduates' Section), at 7.—H. C. Peters: Submerged Combustion and Submerged Flame Burners.

Surveyors' Institution, at 8.—E. M. Konstam: The Rating and Valuation Act, 1925.

Royal Geographical Society (at Æolian Hall), at 8.30.

Medical Society of London, at 8.30.—H. W. Carson, Dr. A. F. Hurst, and Dr. T. W. Eden: Discussion on Right Iliac Fossa Pain.

TUESDAY, FEBRUARY 9.

Manchester Geological and Mining Society, at 4.

Royal Institution of Great Britain, at 5.15.—Dr. E. K. Rideal: Surface Action (2).

Institution of Petroleum Technologists (at Royal Society of Arts), at 5.30.—Dr. F. Challenger, J. Haslam, R. J. Bramhall, and J. Walkden: The Sulphur Compounds of Kimmeridge Shale Oil.

British Institute of Philosophical Studies (at Bedford College for Women), at 5.30.—Prof. L. J. Russell: Modern Science and the Nature of Matter.

Zoological Society of London, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the months of November, December, 1925, and January 1926.—R. I. Pocock: (1) The External Characters of an Adult Female Chinese Pangolin (*Manis pentadactyla*); (2) The External Characters of a Young Female Rodent, *Dinomys branickii*, exhibited in the Society's Gardens.—Dr. R. Broom: On the Mammalian Presphenoid and Mesethmoid Bones.—W. N. F. Woodland: On the Genera and Possible Affinities of the Caryophyllaeidae—a Reply to Drs. O. Fuhrmann and J. G. Baer.—H. G. Jackson: Wood-lice from Spain and Portugal, with an Account of Benthana, a Subgenus of Philoscia.—Crustacea.—R. A. Wardle: The Respiratory System of Contrasting Types of Crane-fly Larvæ.—R. A. Wardle and Elizabeth A. Taylor: The Cephalic Skeleton of Contrasting Types of Crane-fly Larvæ.—Dr. H. C. James: The Anatomy of a British Phytophagous Chalcidoid of the Genus Harmolita (Isosoma).

Institution of Civil Engineers, at 6.—P. W. Bertlin: Construction of the New Entrance to Tranmere Dock.

Institution of Electrical Engineers (East Midland Sub-Centre) (at College, Loughborough), at 6.45.—R. C. Clinker: The Constants of an Electric Circuit.

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.

Royal Photographic Society of Great Britain, at 7.—Scientific and Technical Group.—L. F. Davidson: Conditions governing the Behaviour of the Silver Bromide Grain during Development. Part II.—S. O. Rawling: A Note on Stopping Development in Plate Testing.—Dr. Walter Clark: Note on a Small Mercury Vapour Lamp for Laboratory Use.

Society of Chemical Industry (Birmingham and Midland Section) (at Birmingham University), at 7.15.—A. W. Knapp: The Drying of Vegetables.

Institute of British Foundrymen (Burnley Section) (at Municipal College, Burnley), at 7.15.—H. Shackleton: A Talk on Foundry Work.

Institution of Electrical Engineers (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—Prof. S. P. Smith: An All-Electric House.

Institution of Engineers and Shipbuilders in Scotland (at 39 Elmbank Crescent, Glasgow), at 7.30.

Quekett Microscopical Club, at 7.30.—Sir David Prain: Presidential Address.

Institution of Mechanical Engineers (Swansea Branch).

WEDNESDAY, FEBRUARY 10.

Institution of Heating and Ventilating Engineers (Annual General Meeting) (at Holborn Restaurant), at 2.30.—H. G. Cathcart: Engineering Services in Hospitals and Asylums.

Institute of Hygiene, at 3.30.—Sir Harry Baldwin: The Dental Problem in relation to School Children.

Royal College of Surgeons of England, at 5.—Prof. A. L. Abel: The Treatment of Cancer of the Œsophagus.

Eugenics Education Society (at Royal Society), at 5.30.—Dr. H. F. Humphreys: Evolution of the Prehistoric Races.

British Institute of Philosophical Studies (at London University Club), at 5.30.—Hon. Bertrand Russell: Causal Laws.

Institution of Civil Engineers (Informal Meeting), at 6.—W. A. Willox: British Railway Permanent-way Maintenance.

Radio Society of Great Britain (Informal Meeting) (at Institution of Electrical Engineers), at 6.

North-East Coast Institution of Engineers and Shipbuilders (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.—Dr. E. V. Telfer: Nomograms.

Glasgow University Alchemists' Club, at 7.30.—Sir John Russell: The Feeding of Plants: Old and New Ideas.

Royal Society of Arts, at 8.—Prof. J. C. Drummond: Modern Views of Vitamins.

Leeds Philosophical Society, at 8.—Prof. D'Arcy W. Thompson: The Labours of Hercules and their Astronomical Significance.

Electroplaters' and Depositors' Technical Society (at Northampton Polytechnic Institute), at 8.15.—E. A. Ollard: A General Survey of Chromium Plating.

Institution of Structural Engineers (Lancashire and Cheshire Branch).—Prof. A. E. Richardson: The Relation of Architectural Design to Structure.

THURSDAY, FEBRUARY 11.

British Science Guild (Conversazione) (at Carpenters' Hall, Throgmorton Avenue), at 4.30.—Addresses on The Scientific Approach in Administrative Problems; The Use and Abuse of the "Conference" Instrument; Losses from Avoidable Fires; Losses from Timber Disease.

Royal Society, at 4.30.—H. G. Thornton and N. Gangulee: The Life Cycle of the Nodule Organism *Bacillus radicicola* (Beij.) in Soil and its Relation to the Infection of the Host Plant.—C. E. Walker: The Meiotic Phase in certain Mammals.—J. Needham and Dorothy Needham: Further Micro-Injection Studies on the Oxidation-Reduction Potential of the Cell Interior.—Dr. J. W. H. Harrison and F. C. Garrett: The Induction of Melanism in the Lepidoptera and its subsequent Inheritance.—J. Gray: The Mechanism of Ciliary Movement. V. The Effect of Ions on the Duration of Beat.—N. H. W. Maclaren: The Early Development of Cavia: Note on Associated Remains of previous Placentation.

London Mathematical Society (at Royal Astronomical Society), at 5.

Royal Institution of Great Britain, at 5.15.—Dr. J. L. Myres: Who were the Greeks? (3).

British Institute of Philosophical Studies (at Royal Anthropological Institute), at 5.30.—H. J. Laski: Internationalism.

Institution of Electrical Engineers (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—T. Carter: The Engineer: His Due and his Duty in Life.

Optical Society (at Imperial College of Science), at 7.30.—F. W. Preston: The Nature of the Polishing Operation.—W. M. Hampton: The Annealing and Re-annealing of Glass, Part III.: The Determination of Annealing Temperatures; Part IV.: The Annealing of Glass at Low Temperatures.

Royal Technical College Civil Engineering Society (at Royal Technical College, Glasgow), at 7.30.—J. G. Smith: Construction of Kirkcaldy Sea Wall and Esplanade.

Chemical Society (at University College), at 8.—Prof. J. Barcroft: Hæmoglobin (Lecture), and Demonstrations by Drs. Hartridge and Roughton, Dr. Keilin, Prof. Barcroft and Dr. Hecht, Mrs. Kerridge, R. Hill and G. S. Adair.

Society of Dyers and Colourists (Manchester Section).—W. N. Burbridge: Rubber Softeners.

Oil and Colour Chemists' Association.

FRIDAY, FEBRUARY 12.

Royal Astronomical Society, at 5.—Anniversary.

Physical Society of London (at Imperial College of Science), at 5.—Annual General Meeting.

Royal College of Surgeons of England, at 5.—Prof. H. W. B. Cairns: Neoplasms of the Testicle.

British Institute of Philosophical Studies (at Royal Anthropological Institute), at 5.30.—Prof. T. H. Pear: Sleep and Dreams.

Malacological Society of London (at Linnean Society), at 6.

Women's Engineering Society (at 26 George Street, W.1), at 6.30.—Miss E. M. Kennedy: Some Problems of the Machinery Market (Lecture).

Institution of Electrical Engineers (South Midland Centre) (jointly with Institutions of Civil and Mechanical Engineers) (at City Council Chamber, Birmingham), at 7.—C. O. Silvers and others: Road Transport and its Possible Developments.

Institution of Mechanical Engineers (Informal Meeting), at 7.—G. C. Hodsdon and others: Discussion on Refrigerating Machinery.

Institution of Engineering Inspection (at Royal Society of Arts), at 7.30.—S. E. Dawson: The Application of Special Cast Irons in the Engineering Industry.

Junior Institution of Engineers, at 7.30.—W. H. Patchell: A Visit to some Power Stations in the U.S.A. in 1925 (Lecture).

North-East Coast Institution of Engineers and Shipbuilders (at Newcastle-upon-Tyne), at 7.30.—E. Berg: Electrical Propulsion of Ships.

Royal Society of Medicine (Ophthalmology Section), at 8.30.—P. G. Doyne: Ocular Torticollis.—L. Rea: Plastic Repair of Perforations of the Cornea.

Royal Institution of Great Britain, at 9.—Prof. R. Robinson: The Chemistry of Blue and Red Colouring Matters of Flowers.

Institution of Mechanical Engineers (Leeds Branch).—A. P. Hague: The Choice of Steels for Engineering Work.

West of Scotland Iron and Steel Institute (at Royal Technical College, Glasgow).—H. J. Young: Grey Iron Castings for Special Needs.

SATURDAY, FEBRUARY 13.

North of England Institute of Mining and Mechanical Engineers, at 2.30.

Royal Institution of Great Britain, at 3.—Sir Walford Davies: The Third and the Perfect Fourth (2). Their Uses from Hucbald to the Present Day.

British Psychological Society (at Bedford College for Women), at 3.—Dr. M. H. Magson: Judgments of Intelligence based upon Interviews.—R. J. Bartlett: Indications of a Logarithmic Law in Learning.

Scottish Junior Gas Association (at Royal Technical College, Glasgow), at 7.—A. Philip: Municipal Gas Undertakings: Finance and Accounting.

Mining Institute of Scotland (at Edinburgh).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 6.

Horniman Museum (Forest Hill), at 3.30.—W. J. Perry: The Quest for Gold and Pearls in Ancient Times.

MONDAY, FEBRUARY 8.

University of Leeds, at 5.15.—Prof. A. Harden: The Carbohydrate Metabolism of Micro-organisms.

King's College, at 5.30.—Dr. F. A. P. Aveling: The Human Will (4): Modern Views—Theoretical.

TUESDAY, FEBRUARY 9.

King's College, at 5.30.—Miss Hilda D. Oakeley: Philosophy and History (2): Theories of Croce and Gentile.

FRIDAY, FEBRUARY 12.

University College, at 5.—Dr. G. Martin: The Theory of Fine Grinding.

Municipal Technical School, Birmingham, at 7.15.—Dr. J. Newton Friend: Historical Chemistry: Joseph Priestley.

Birkbeck College, at 6.15.—Capt. F. Maccunn: Educational and other Methods of Promoting the Humane Treatment of Animals.

SATURDAY, FEBRUARY 13.

Horniman Museum (Forest Hill), at 3.30.—H. N. Milligan: Sea-Shells and their Makers.

The equipment of this remarkable expedition was superb. In the selection of each instrument, the test applied was that it should be the best for the purpose within the limits of weight and dimensions suitable for human transport. It included a zenith telescope of 615 mm. focal length for latitude observations; for time and azimuth determinations, a telescope with two stands, so as to serve either as a transit instrument or as a 12-in. theodolite; a pendulum apparatus for determining gravity; a chronograph and a number of chronometers, mercurial barometers and hypsometers, sextants with tripod stands and mercury troughs, tacheometers, a level, a base-measuring apparatus, instruments for determining the magnetic elements, besides gas cylinders, pilot balloons, a radio-telegraphic set, photographic apparatus, plates and films.

The accounts are written by the experts who were in charge of the several operations, namely: Capt. A. Alessio, who later became hydrographer of the Italian Navy; Prof. G. Abetti, of Florence; Mr. J. A. Spranger and Lieut. C. Antilli, of the Italian engineers.

The latitude observations (Chap. i.) are very clearly described by Prof. Abetti. Eleven principal latitudes were observed with probable errors varying from ±0″·11 to ±0″·34, the average being ±0″·17. This is a precision which is more commonly associated with major geodetic operations than with the exploration of little-known regions of great natural difficulty; indeed, a very striking feature of this expedition is the contrast between the difficulties of the region and the refinement of the methods employed.

The time determinations (Chap. ii.) were undertaken, first, for the determination of the difference of longitude between the stations of the expedition and Dehra Dun, the headquarters of the Trigonometrical Survey of India, and secondly, for finding the rate of the chronometer used in timing the pendulums in the gravity observations.

As there was no wireless station in India for the emission of controlled time signals, it had been arranged that at certain hours, on certain days during a considerable period, the wireless station at Lahore should emit a series of suitable signals. A comparison of the local time of the reception of these signals at Dehra Dun and at a station of the expedition gives the difference of longitude of the latter from Dehra Dun. In this way the longitudes of eight stations were determined, and at each of them the latitude was also observed. Of these stations, Skardu, Ḳarghil, Lamayura, Leh and Depsang are connected with India by triangulation. At each of these five, therefore, it will be possible to determine the total local deflexion of the plumb line, and these observed values, together with the values calculated by Hayford's method on the isostatic hypothesis, will appear in Vol. 2 of this series and should yield results of the highest interest. The remaining three stations at which the latitude and longitude were determined are Sughet Karol, Yarkand and Kashgar, all in Turkestan. The positions of the last two were tolerably well known, but the fixation of Sughet Karol adds a useful point in a little-known region.

In Chap. iii, on the determination of positions by the methods of nautical astronomy, Capt. Alessio discusses the advantages for both latitude and time determinations of the prismatic astrolabe as compared with a zenith telescope and transit instrument. His decision was in favour of the latter. For use at secondary stations, where portability was of first importance, he declared a distinct preference for a sextant mounted on a tripod stand with mercurial horizon. It would be interesting to know whether he would come to the same decision to-day, fourteen years later, if the same choice lay before him. In such a matter, personal predilection must always be a factor of importance, yet with an observer so versatile and so practised as Capt. Alessio, it is unlikely that predilection was confined to narrow limits, and this fact gives special interest to the discussion and to his decision This chapter also contains an account of the watch kept on the rate of the chronometers and of the determination of various differential longitudes by the transport of some of them. This method was only employed when wireless was not available; indeed, the strong battery of chronometers included in the equipment was intended as a *pis aller*, in case it had been found impossible to arrange for the emission of wireless signals.

Chap. iv. contains a very complete account of the determination of altitude by barometers and hypsometers, also by Capt Alessio. Five mercurial barometers came with the expedition from Genoa, and an additional and particularly good instrument was brought by Prof. Alessandri, who carried it—*in senso assoluto*—all the way from Italy to Leh! Of the six, only the last came safely back to Italy; all the others succumbed sooner or later to the vicissitudes of the journey. The care expended on the treatment and on the comparison of these barometers, and the attention to detail in the deduction of altitude from the data obtained, are worthy of study by any one who contemplates making observations of the kind. Indeed, the whole chapter is more like an account of a careful experiment in physics than that of the operations of a party of explorers.

Results obtained with hypsometers are compared with those deduced from the barometers, and Capt. Alessio arrives at the following conclusions: (*a*) That in determinations of atmospheric pressure with a hypsometer, the accidental error of reading is negligible in comparison with the analogous error in reading a barometer; (*b*) that the correction to a hypsometer is a function of the prevailing low pressure and temperature, and tends to increase positively as the prevailing pressure diminishes and as the prevailing temperature increases; (*c*) that if, but only if, it is possible to ascertain the effects of the above two causes (long-continued low pressure and temperature), then a determination of atmospheric pressure with a fully standardised hypsometer is of the same order of accuracy as a determination with a mercurial barometer of the best quality and observed under the most favourable conditions. Great stress is laid on the need for study of thermometers when subjected to such conditions, and it is suggested that the Monte Rosa Observatory might undertake such an investigation.

The triangulation which forms the framework for the map of the area surveyed is dealt with by Mr. J. A. Spranger in Chap v After the establishment of the base camp on the Depsang Plateau, the weather was at first so bad that it was found impossible to make a satisfactory connexion with known peaks, and it was determined to measure a base and start an independent triangulation resting on an astronomically observed latitude and azimuth. However, a week later the weather cleared, and it was then possible to observe peaks in all directions, including several fixed by the Indian triangulation; among these were K^2 and one of the Teram Kangri peaks The chart of the triangulation shows that the system divides into two parts, the dividing line running east and west through the Karakoram Pass, and that the connexion between the two parts is weak. Fortunately, it was found possible to fix the ultimate station towards the north by means of rays to well-fixed points, namely, the Gasherbrum peaks and another (12/52E) which had already proved useful in the southern portion This gives a valuable check, and we may feel confident that the positions of the numerous points on which the topography depends are correct enough for their purpose. The work was immensely difficult, and the success achieved reflects great credit on Mr. Spranger and Major Wood, R.E., who jointly carried it out; nor must we omit to mention the names of the two Indian surveyors, Jamna Pershad and Shib Lal, who did the plane-tabling, and of whom Dr. De Filippi speaks in very appreciative terms.

All the stations at which observations were made are fully described in a special chapter, together with the details of the connexion with the Indian triangulation. The descriptions are supplemented by photographs with arrows marking special peaks, and other arrows in the margins which by their intersection indicate the exact position of the astronomical instrument or the gravity apparatus as the case may be. The care bestowed on these details is much to be commended. Trouble has often been caused in the past by the difficulty of identifying points about which some important fact had been laboriously ascertained

The introduction, which we deliberately mention last, is a masterly summary by Dr. De Filippi of the whole campaign. It is illustrated by a map of the whole region, on the scale of 1/2,500,000, showing the routes followed by members of the expedition. Large-scale maps of Rimu Glacier and of the new area surveyed have already been published in the general report.

It must be remembered that the Eastern Karakoram is one of the most barren and inhospitable regions of the world, cut off from civilisation by hundreds of miles of extremely high mountains where passes are few and liable to be closed by snow even in summer, and that there are no roads or bridges—only rough tracks along the valleys, where possible, or with astounding gradients up and down steep slopes where the water is bank high.

The scientific instruments, camp material and personal luggage of the Europeans alone weighed four tons and required sixty horses and twenty porters, quite apart from the necessary supplies (some six and a half tons) of European food. So carefully had the details been thought out, that all this mass of material was so subdivided that in no case was the work of individual groups hampered, though frequently they were separated by two hundred miles or more from the main party. The first seven months from the end of September 1913 had been spent in strenuous work in and around the Upper Indus valley Meanwhile some fifty tons (about 2250 sacks) of food for the porters and fodder for the horses and yaks had to be assembled in the vicinity of Leh ready to be sent forward as early as the condition of the passes into and out of the Shyok valley made it possible. Everything was timed to a nicety; the whole party, with the scientific equipment and all necessary supplies, assembled early in June 1914 a few miles south of the celebrated Karakoram Pass, on the Depsang Plateau (17,590 ft.), which was to be the headquarters of the expedition for nearly three months.

In this introduction, as in the general report, we realise with pleasure how cordial were the relations between the expedition and the several departments of the Government of India with which it had contact, and also what friendly relations subsisted with the Kashmiri officials, with the caravan leaders and the natives generally. But the most striking feature of both accounts is the simplicity and directness of the narrative, together with the modesty and self-effacement of the writer. The funds so liberally subscribed in Italy were obviously used to the best advantage. Each member of the party was selected as being a specialist in his own branch and devoted unremitting efforts to accomplish the utmost possible. It is not surprising that the investigations have yielded such important results, for it is a fine example of successful team work Yet the reader's attention is so persistently directed to the activities of the various groups that he is apt to forget that the success is very largely due to Dr. De Filippi's master mind, and that his genius as organiser made it possible, not only to carry out all the main objects of the expedition, but also to branch out in other directions far beyond the area originally selected for scientific research.

B. B. D
G. P. L.-C.

The Kinetic Theory of Heat.

Müller-Pouillets Lehrbuch der Physik. 11 Auflage. Dritter Band, Zweite Halfte: *Kinetische Theorie der Warme.* Von Karl F. Herzfeld. Pp. x+436 (Braunschweig: Friedr Vieweg und Sohn A.-G., 1925.) 21 gold marks.

It is stated in the preface to this treatise on the kinetic theory of heat that there exists, on one hand, a number of adequate works on the kinetic theory of gases, and on the other hand, a number of very complete treatises on statistical mechanics, but that there is no text-book which gives a comprehensive treatment of the various applications of the kinetic theory in a convenient form. This gap Prof. Herzfeld has set out to fill, and he has been so successful that we could wish that his work was available for English students in their own language.

The first chapter contains an elementary treatment of the kinetic theory of gases, and it is at once evident that the author clearly realises the great importance of stating the precise mathematical and physical interpretation of every assumption made and of every equation obtained, a fact which contributes in no small measure to the success of the book. The discussion of the Maxwell distribution of velocities is accompanied by clear descriptions of Bahr's work on carbon dioxide bands, Stern's investigations of molecular velocities, and the work of Cantor, Minnaert, and Wulf. The portion of the chapter devoted to the consideration of the viscosity of gases and allied phenomena contains short sections on the Gaede molecular pump, the Knudsen absolute manometer, and the diffusion pump.

The second chapter deals with general statistical mechanics; the author has again tried as much as possible to emphasise the physical meaning of each statistical formula, and the use of very advanced mathematics is avoided. The treatment of the behaviour of [illegible] apter loses a good deal of its reference value by the omission of any account of the numerous attempts, other than that of Van der Waals, which have been made to obtain a satisfactory equation of state. The author considers them to be practically useless, but, whether that be so or not, they are at least of considerable interest, and, after all, much other scientific work has, in all probability, little further claim on our attention. The English reader must deem it remarkable that in this chapter of forty pages, containing nearly ninety references to original papers, only three of these references are to the work of English and American workers, namely, to the work of Dushman, Rideal, and "McLewis."

The succeeding chapters on solids, the theory of fluids, and the theory of solutions are very extensive, and the sections on sublimation and liquid crystals are of special interest. An excellent treatment of Brownian motion is given in the chapter on the theory of fluctuations, and the developments of the quantum theory, in so far as they affect the kinetic theory, are concisely introduced in Chap. viii. The final chapter deals with the determination of the Loschmidt number and of the absolute dimensions of molecules; it contains a brief account of Rankine's work on this subject, and concludes with a short history of the development of the atomic hypothesis.

The book forms a valuable work of reference, and can be more particularly recommended to those workers who, being conversant with recent English contributions to its subject matter, require ready access to the results of German investigators.

Indian Botany.

The Botany of Bihar and Orissa: an Account of all the known Indigenous Plants of the Province and of the most Important or most commonly Cultivated Exotic Ones. By H. H Haines. (Published under the authority of the Government of Bihar and Orissa.) In 6 Parts. Part 1. Pp. x+199. 8 rupees. Part 2. Pp. 224. 10 rupees. Part 3: *Calycifloræ.* Pp. 225-418. 9 rupees. Part 4: *Gamopetalæ.* Pp. 419-754. 13.8 rupees. Part 5. Pp. 755-1058. 11 rupees. Part 6, including Appendices and Index to Parts 2-6. Pp. 1059-1350. 10.8 rupees. (Calcutta. Thacker, Spink and Co.; London: W. Thacker and Co., 1921–25.)

With the issue recently of Part 1, Mr. H. H. Haines has brought to a conclusion his account of the botany of Bihar and Orissa, and removed thereby another large slice from the area of Peninsular India not yet provided with a flora of its own. The first part was published in 1921, so that the work has been completed in the short space of four years. It must not be thought, however, that it is the product of only forty-eight months of labour, for Mr. Haines had been working on it before he left India, and indeed the contents themselves are full of evidence of the careful preparation of years of research in the field and in herbaria, and of personal acquaintance with the living plants in their natural habitat.

The system of classification adopted closely follows that of Bentham and Hooker with some modifications; *e.g.* the Euphorbiaceæ follow immediately after the Tiliaceæ. This arrangement is not because the author is convinced that it is inherently the best, as indeed will be realised from a study of his discussion on taxonomy and classification, but because, being that followed by most English herbaria, it is the most convenient for English field botanists.

Mr. Haines has taken great pains to give the correct botanical nomenclature according to the International Rules, and to adopt the later developments in raising some of the Bentham and Hooker tribes to the rank of families; *e.g.* with the Urticaceæ. Even when one does not entirely agree with him, his expositions are always illuminating. The keys to the families and genera are Mr. Haines's own and are generally clear and easily applied, and the descriptions are sufficiently detailed to enable any field botanist to make quite certain of his identification. That they are accurate needs no assertion; they are based on intimate and painstaking observation and the study of type specimens. Localities of occurrence and dates of flowering and fruiting are furnished for each species, and also notes on the uses of various parts of the plant.

Part 1 is the most interesting from the general aspect, as it includes, besides a fairly detailed and very interesting account of the area comprised and its topography, geology, and climate, an arresting and lucid dissertation on the general character of the flora, which denotes a most intimate acquaintance with the tract as well as a love for the study of its flora. The chapter on taxonomy and classification is thoughtful and stimulating, and concludes with a conspectus of orders and families in their interrelationship as conceived by the author. The part concludes with a glossary of the botanical terms used and an index for this part—there being a separate index at the end of Part 6 for the other five parts, which are devoted to the descriptive flora itself.

An outline map of the distribution of the rainfall is attached to the chapter on climate, and in a pocket at the end of Part 1 will be found a good topographic map of the Province. The type and paper are excellent, and there can be nothing but praise for this achievement of Mr. Haines, for which all botanists, and particularly those directly interested in the locality, will be grateful.

Our Bookshelf.

Die Tierwelt der Nord- und Ostsee. Herausgegeben von G. Grimpe und E. Wagler. Lieferung 1 (Teil VI. d, VII. a, XI. a). Teil VI. d: Echiuridæ, Sipunculidæ, Priapulidæ, von W. Fischer; Teil VII. a: Enteropneusta, von C. J. van der Horst, Teil XI. a: Pantopoda, von Johannes Meisenheimer. Pp. 55+12+12. (Leipzig: Akademische Verlagsgesellschaft m. b. H., 1925.) 4·80 gold marks.

THE series of which this forms the first section is planned to give an account—systematic, biological, ecological—of the fauna of the North Sea and the Baltic, and is expected to be completed in about 2000 pp. in three years. Each part deals with one group of animals, is separately paged, and bears a number in Roman figures and a letter, so that eventually all the parts with the same Roman figure can be placed together and bound in the sequence indicated by the letters; *e.g.* all the parts on Cœlenterata will be headed "III." followed by one of the letters a-f according to the class or order—the part on Ctenophora will be marked "III. f."

The accounts are intended to be of service to those teachers, students, and amateurs who wish rapidly to refer to the systematic characters and to ascertain the principal facts in the biology of the animals of the area. The descriptions of external and internal characters are necessarily brief, and some previous knowledge is necessary for a proper understanding of the text, but a good third-year student should find little difficulty in using the work.

In Dr. Fischer's part, the Echiuridæ, Sipunculidæ, and Priapulidæ are treated separately. A statement of the characters of the family is followed by a key to the genera. A short diagnosis of each genus and species is given, the localities in the North Sea and the Baltic from which the species has been recorded are mentioned and shown on a map, and the general distribution briefly indicated. In the space of about a couple of pages, a summary is given of the anatomical features which can be made out by the naked eye or with the help of a lens or a binocular dissecting microscope, with references here and there to microscopic structure. Locomotion, food, reproduction, and development are successively considered, and attention is directed to parasites and to those members of the family which commonly serve as food to fishes. Dr. Fischer's work is well up-to-date; it includes, for example, adequate notice of the investigations of Baltzer on Bonellia (1914 and 1924), and appended is a list of works of reference. The illustrations on the whole are good; a better one of the female Bonellia might have been given.

The account of the Enteropneusta follows similar lines. In the part on the Pantopoda a key is given to families only; this part would have been much more useful if keys had been added for the genera and for the fifteen species.

Judging from the portion before us, the series is likely to fulfil its functions very satisfactorily. We cordially wish success to the enterprise, which should result in placing in the hands of those whose work or pleasure leads them to examine the fauna of the North Sea the means for rapidly determining their captures, and for ascertaining the

The Radio Year-Book 1926 (Fourth Year): a Book of Reference for all Interested in Broadcast Receiving. Pp. xiv + 182. (London: Sir Isaac Pitman and Sons, Ltd., 1926.) 1*s.* 6*d.* net.

This book will prove of value to all who listen to broadcasting. Photographs are given of many of the eminent men and of many of the popular artistes who have spoken or performed before the microphone during the past year. So far as British broadcasting is concerned, this year will be a momentous one, as the Government will have to come to a decision regarding the future of the British Broadcasting Company. The book is not a mere record of past achievements; many of the contributions look into the future and make conjectures as to new developments. Mr. Thorne Baker discusses the problem of the radio transmission of visual images. He shows that theoretically it is possible to have a screen in one's home on which, for example, the progress of the yachts at a regatta, possibly hundreds of miles away, could be watched. He points out the difficulties in the way, but says that they have nearly all been overcome by Mr. Baird.

The technical section of the book gives many useful hints on the management of receiving sets and aerials. A chapter has been included on "speaking" films by Mr. Elwell; the reason being that the three-electrode valve has proved of the greatest value in this connexion. Dr. Lee de Forest is rightly given the credit of being the pioneer of perfectly synchronised talking motion pictures, which are called "phonofilms" in America. We learn that the talking motion picture in a commercially perfect form will shortly be introduced into Great Britain. A chapter is also devoted to loud-speaker extensions, and a system of wiring the various rooms of a house so that each room can have its own loud speaker or head-phones if so desired is described. A drawback to the method, however, is that if one is speaking in a room with a loud speaker, a listener on the phones in another room hears most of what is said.

Intermediate Mathematics (Analysis). By T. S. Usherwood and C. J. A. Trimble. Pp. xii + 457 + xxiv. (London: Macmillan and Co., Ltd., 1925.) 7*s.* 6*d.*

The authors of this text-book on mathematics to the intermediate degree standard have already established a reputation by their previous works which is fully maintained in the present. The book is well planned. It commences with simultaneous and quadratic equations and moves easily to the study of simple graphs and their applications to the determination of observational laws and to the approximate solution of equations. Following a chapter on algebra there come two on trigonometry and one on co-ordinate geometry. The three succeeding chapters return to algebra. Chaps. xi. and xii. deal respectively with vectors and trigonometry of the triangle, and the book is completed with two chapters on the calculus up to elementary differential equations.

The book is well supplied with an admirable collection of varied examples. The argument is well developed and evidently based on a critical teaching experience. If a suggestion may be offered, it is that the subject of vectors is too much segregated within its one chapter. There is no reason why it could not be reintroduced in examples of differentiation, integration and differential equations. Applications of the method of least squares might, moreover, with advantage be introduced into the sections treating of maxima and minima and the determination of observational laws.

In Praise of Birds: Pictures of Bird Life. Described and photographed by the Rev. Canon Charles E. Raven. Pp. xiv + 148 + 48 plates. (London: Martin Hopkinson and Co., Ltd., 1925.) 14*s.* net.

Dr. C. E. Raven, Canon of Liverpool, has produced an attractive volume in praise of birds and of bird-watching. The story of his quests shows him to be an ardent bird-lover who takes a proper pleasure in every aspect of bird-life and in every opportunity of studying it on intimate terms. His photographs are evidence of much patient zeal: they are of varying merit, but the best are very good indeed. The author takes us from Cambridge to Surrey, with occasional excursions elsewhere; and finally on a visit to the Dutch coast, to the ornithological wonders of which about half the book is devoted. Incidents both of bird-life itself and of experiences in watching and photography are pleasingly described, and a happy enthusiasm for the subject pervades the whole account.

Physik in graphischen Darstellungen. Von Felix Auerbach. Zweite Auflage. Pp. xii + 257 Tafeln + 29. (Leipzig und Berlin: B. G. Teubner, 1925.) 14 gold marks.

The author of this work must be a real enthusiast for graphical representation. From every branch of mathematics—pure and applied—physics, chemistry, and metallurgy, he has collected together graphs and drawings to illustrate the principal features and the most critical phenomena of these subjects. In many cases the drawings are new, but more frequently they are reproductions of those that appeared in the original memoirs dealing with the particular phenomenon. In all there are 1557 figures in 257 pages, followed by 25 pages of short explanations of each figure, with references. The drawings are well reproduced and combine together to provide a most interesting "picture" book for the scientific worker.

The Configuration of the Saccharides. By Prof. Dr. J. Böeseken. Translated into English from the Dutch by Dr. Samuel Coffey. Part 1: The Configuration of the Monosaccharides. Pp. iii + 71 + iv. Part 2: The Configuration of the Polysaccharides. Pp. ii + 58 + iii. (Leyden: A. W. Sijthoff's Publishing Co., n.d.) n.p.

In these two monographs, the professor of pure and applied organic chemistry in the Technical University of Delft, Holland, has presented a clear and succinct account of the investigations which have led to the most recent views on the molecular configurations of the members of the sugar group. The work is well done and will be valued as a handy and accurate résumé by the research worker, the lecturer, and the student. Although quite intelligible, the translation appears to be too literal, and we fear that much of the phraseology employed would not be passed by the Society for Pure English.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On One-Eyed Vision.

I CALL "solid" or "three dimensional" vision the faculty of the brain to interpret the flat retinal images so as to give the impression of a three-dimensional space. A person with two healthy eyes views the same object from two slightly different angles, when the muscular effort required to bring the two images into coincidence serves as the guide for estimating the distance. This is the generally accepted explanation, but shortly after I had lost the sight of one eye, a friend expressed doubts of its sufficiency on the ground that if he alternately shut and opened one of his eyes, he noticed very little—if any—difference in the three-dimensional impression. I could understand his scepticism, because previous to my accident I had experimented in the same way with the same result. Since then experience has shown me that there is a very substantial distinction between the permanent and temporary closing of one eye.

Before explaining the inconclusive nature of the described experiment, we may consider what powers the one-eyed person retains to help him in estimating the distance of an object. So long as he is young, he may find sufficient assistance in the focussing effort of the eye, but in old age, when that power is gone, what is left?

Everybody who is in the habit of visiting picture galleries must have occasionally come across a painting which gives an almost compelling illusion of a three-dimensional space. Apart from the imitation of atmospheric effects, it is the correct perspective and the true appreciation of the relative sizes of the objects that give a feeling of solidity, which artists occasionally enhance by wilful exaggeration. A picture has the same appearance whether looked at with one eye or two, and it is the "perspective" vision—as it may be called—on which in old age a person who has lost one of his eyes has to depend.

One-eyed vision is not flat, but it is untrustworthy because the unconscious mental process involved, depending on a knowledge of the dimensions of objects and their relation to the apparent sizes, is liable to be seriously at fault. A few examples derived from experience may illustrate this.

If we are accustomed to a wine glass of a certain size we may fill it with fair safety, but if another glass of similar shape and different size is substituted the result may be disastrous; we have a wrong idea of size in our mind, and this leads to a wrong impression of distance. In our homes we are familiar with most of the objects that surround us, but there are some exceptions. I find flowers in a room difficult to locate when the receptacle in which they are placed happens to be hidden. The flowers then seem to cling to the object with which they are in apparent contact. They may appear in the hair or in the hat of a lady sitting in front; and within the last few days I have seen a man drinking his tea with two fine roses growing out of his bald skull. The same is true of moving objects. A fly passing quickly across my field of vision is almost indistinguishable from a bird flying across the window. If such errors occur when we are fully conscious, they are much more striking at the moment of awakening from sleep. Once, in a somnolent condition, I had the firm impression of seeing in a corner of my study what looked like a tin box perhaps 18 inches long and 6 inches high; but rousing myself I found I was looking at a small tin cigarette box standing on a table beside me.

Most people know how, even with full command of two eyes, their sight may be interpreted in different manners. A rotating cup-anemometer may, for example, look as if the direction of rotation were inverted. Similarly, if a transparent cube be drawn in perspective, all twelve edges showing, we may by an effort of mind get two entirely different impressions of the cube, in which it appears as seen either from above and the right, or from below and the left. Similarly, a cone drawn in outline may appear to be turned inside out by an effort of the will. This shows how much the mind is concerned in the process of solid vision.

If we now return to the experiment described in the opening paragraph, we realise that the two-eyed person looking round a room has a firm impression of the three-dimensional relations of the objects he sees. That impression remains when he shuts one eye, and he is not conscious of any difference. He would have to bandage one eye for some time and go into new surroundings before the test could have any value.

There is another set of interesting and puzzling impressions which lie outside the immediate objects of this communication. It concerns objects in motion. We know all motion to be relative, but nevertheless when a moving train passes a stationary one a passenger in either of them, disregarding relativity, forms a definite and often wrong impression as to whether he is moving or at rest. During the first few months after I had lost one eye, an unconscious swaying of my head always appeared to me as a motion of the surrounding objects, and when these objects were close to my face a most unpleasant sensation of their rapid approach resulted.

I may in conclusion refer to the well-known interpretation of the apparent size of the moon when near the horizon, as showing how much psychological processes affect the interpretation we give to what our eyes perceive.

ARTHUR SCHUSTER.

Yeldall, Twyford,
Berks.

The "Modified Scattered" X-Radiation.

MAY we now supplement what we have already told regarding the scattering of X-rays by stating that we now know quite definitely that even after the *J*-transformation has taken place in a scattered X-radiation and this has become a "modified scattered" radiation when its absorbability is measured in certain substances, it has, even after passing through those substances, precisely the same absorbability as the primary when measured in certain other substances.

This is in perfect agreement with the generalisation we have already made that there are various definite levels of activity of an X-radiation in any substance, the level depending upon the whole of a more or less complex beam, and that a change of the activity in one substance from level to level may take place without the least indication of any corresponding change in a second substance. What we have now found is, that the penetrating powers of secondary and primary radiations are equal in some substances *subsequent* to transmission through plates of material which exhibit or produce the difference.

What then of Compton's hypothesis, and more important still, the second line obtained in the spectrum of the scattered radiation? Can the wavelength of a radiation change without producing a corresponding [illegible] orption in *all* substances?

In answer, we must point out that we have already demonstrated that a change in the activity (photo-electric action, ionisation, absorption) of a radiation can take place without a change in the wave-length—that wave-length and material substance are not the only factors in X-ray phenomena. In order to reconcile our experimental results with Compton's hypothetical change of wave-length, we should be compelled to go further and state that a change of wave-length may take place without a corresponding change in activity—that is, we should be obliged to dissociate the properties of an X-radiation from wave-length altogether, or at any rate we should have to assume that within certain limits, absorption, electronic emission, etc., are independent of wave-length.

Consequently we are very sceptical as to whether a change in the diffraction angle in spectroscopic measurements really does correspond to a change of wave-length. A measurement of absorption is purely experimental, but a measurement of wave-length is dependent on the adequacy of the classical theory of diffraction, and assumes the absence of any unforeseen phenomenon

It is an experimental fact that the critical condition which governs the change of activity which we have called the *J*-phenomenon is not wave-length, but something analogous to "temperature" of the whole beam of X-rays. Our critical condition for the excitation of the *J*-electronic emission, *J*-ionisation and *J*-absorption is not that the frequency of the primary beam should be higher than a certain critical value, but that this "temperature" shall be higher than a certain value. Thus in place of Stokes' Law which we found to hold for *K* and *L* radiations, we find that in the case of the *J*-phenomenon at least, we may write T_1 must be greater than T_2 where T_1 is the average penetrating power ("temperature") of the beam and T_2 is a penetrating power characteristic of the substance traversed. We use the term "temperature" only tentatively because it is a familiar physical quality which represents most closely, or is analogous to, the state of a complex radiation as measured by penetrating power by ionisation-absorption methods. It seems just possible that Stokes' Law may need to be re-stated in some such way in order to make it more general, and to express what is most fundamental. This, however, is speculative. the experimental facts we have recorded are in a different category altogether, they are beyond dispute.

To summarise, we must accept one of the following possible alternatives.

(1) The second spectral line in Compton's experiments does not represent another wave-length in the secondary radiation incident on the crystal of the spectrometer, or

(2) Wave-length may change without a corresponding change in the activity of an X-radiation This seems possible only on the assumption of the dual nature of radiation in some such way as is suggested by Sir J. J. Thomson, or

(3) The conditions essential to the production of the second spectral line in the spectrum of scattered X-radiation have not been realised in the hundreds of experiments we have made on the phenomenon. This is highly improbable both from the variety of our experiments and from the fact that we do under some conditions obtain what has the *superficial appearance* of a change of wave-length.

The alternative probabilities are thus reduced to (1) and (2)

C. G BARKLA.
S R. KHASTGIR.

The University, Edinburgh,
January 21.

The Energy Levels of the Carbon Monoxide Molecule.

IN a recent communication (NATURE, 116, 170, 1925) I gave formulæ for the two band systems (or "groups") associated with ionised carbon monoxide. These formulæ were afterwards verified (NATURE, 116, 207, 1925) by the discovery of "combination" bands due to the third possible transition between the three known energy levels These electronic levels may be called *X′*, *A′*, and *B′*, in order of increasing energy *A′* is a double level of spacing 126 cm $^{-1}$, while *X′* and *B′* are single. The *A′*-*X′* transition gives the comet-tail bands, the *B′*-*X′* transition the first negative group of carbon, and the *B′*-*A′* transition the new Baldet-Johnson combination bands

In an investigation on the excitation potentials of nitrogen bands, Duncan (*Astrophysical Jour.*, 62, 145, 1925) has observed four systems of bands which he considers to be new nitrogen band systems. I find, however, that his second negative group is the first negative group of carbon, just mentioned above, his seventh positive group is the fourth positive group of carbon, commonly attributed to carbon monoxide, and his fifth positive group is probably the third positive group of carbon, commonly attributed to carbon dioxide I have been unable to identify his sixth positive group. The second negative group is strong, and his value of the excitation potential is therefore doubtless reliable Applying the correction of 1 3 volts which I found necessary in the case of the known nitrogen band systems (NATURE, January 16, p 81), one obtains 19 8 volts for the energy of state *B′*. This gives 14 2 volts as the calculated energy of state *X′*, *i e.* the ionisation potential of CO. The best direct experimental values are 14 3 and 14 1 volts (see p 123, Report of National Research Council on "Critical Potentials").

When writing my letter on the band spectra associated with carbon (NATURE, 116, 170, 1925), I was unable to obtain any satisfactory quantum relations for the fourth positive group. The vibration frequencies of 500 and 3000 quoted there were based on the series arrangement of a portion of the bands of this very extensive system, made by Deslandres and by Lyman. I now find on re-examination of this matter that in this one instance Deslandres arranged the bands in sequences (corresponding to a given *change* in vibrational quantum number) instead of following his usual custom of arrangement in progressions. It is, however, possible to arrange this system in progressions, showing the usual numerical relations, and the new tabulation includes not only all of the bands arranged in series by Deslandres and by Lyman, but also all of Lyman's "fifth positive group" (*Proc. Amer Acad Arts*, 45, 315, 1909), and all of the remaining unassigned bands, with the exception of about a dozen very faint members Approximately 150 bands thus appear on the *n′n″* diagram, the most extensive band system known for molecules of this general type. The heads are given within the rather large limits of error (and with Deslandres' values raised 1 Å U., to be consistent with those of subsequent investigators) by the formula

$$\nu = 64{,}721 + (1499\ 28n' - 17\ 24n'^2) - (2147\ 74n'' - 12\ 703n''^2),$$

where *n′* varies from 0 to 14, and *n″* from 0 to 22. The distribution of intensity is similar to that in the familiar aluminium bands, which I have previously cited as typical (*Phys. Rev.*, 25, 240, 1925).

Investigators agree that this so-called fourth positive group of carbon, which seems always to appear in a vacuum tube discharge when stop-cock grease is used, is due to CO (see Kayser and Konen, vol. 7, p. 141), and direct evidence on this point is now available. Leifson, in an investigation of the absorption of some gases and vapours in the extreme ultra-violet (*Astro. Jour.*, in press), photographed a strong series of narrow absorption bands in carbon monoxide which I find represent, for *absorption*, the 0-0, 0-1, 0-2, etc. to 0-11 transitions, in my arrangement of the fourth positive group of carbon. Since the cold gas was used, only this one progression should appear This definitely establishes the final state of this system (in emission) as the stable state of the carbon monoxide molecule. Moreover, the *final* state of the Ångström CO bands is given by the same progression as the *initial* state of the fourth positive group. Thus the Ångström band heads can be represented by

$$\nu = 22{,}162 + (2158n' - 76n'^2) - (1499{\cdot}28n'' - 17{\cdot}24n''^2),$$

where n'' varies from 0 to 5 or more, and $n' = 0$, 1, and probably 2. This relationship places λ4511 as unquestionably the 0-0 band, a point concerning which there has been some dispute. (See Hulthén, *Ann. d. Phys.*, 71, 41, 1923, and Mecke, *Phys. Zeit.*, 26, 217, 1925.)

The system of electronic energy levels for carbon monoxide thus evaluated consists of X, A, and B for the neutral, and X', A', and B' for the ionised molecule. The transition A-X gives the fourth positive group of carbon, and B-A the Ångström CO bands. From the known structure of these latter bands, B and A are both single levels. The transitions for CO$^+$ have been given. Taking X as the zero level, the energy values of the various levels, in wave-numbers, and in volts, are approximately as follows:

$A = 64{,}721$ cm.$^{-1}$ = 8·0 volts,
$B = 86{,}883 = 10{\cdot}7$ volts,
$X' = 115{,}082 = 14{\cdot}2$ volts,
$A' = 135{,}554$ and $135{,}428 = 16{\cdot}7$ volts,
$B' = 160{,}720 = 19{\cdot}8$ volts.

The 0-0 band of the various systems should thus be excited at the following voltages: fourth group (λ1545) at 8·0 volts, Ångstrom bands (λ4511) at 10·7 volts, comet-tail bands (λ4880) at 16·7 volts, first negative group (λ2190) and "combination bands" (λ3974) at 19·8 volts.

Carbon monoxide is the only molecule, in addition to nitrogen, for which electronic energy levels of both the neutral and ionised state are known, and is the only molecule for which the spectroscopic data are complete. The new information now obtained leads to theoretical results of some significance. These are discussed in a letter on the "Structure of Molecules" to be published in another issue.

RAYMOND T BIRGE.

University of California,
December 19, 1925.

The Dynamics of Surface Action in Closed Vessels.

THE theoretical treatment which has been advanced, and experimentally tested, describing the effect of diluent gases and vapours on the initial stages of catalytic action (see NATURE, vol. 116, pp. 278-279), has been successfully extended to the dynamics of catalytic decomposition in closed vessels. Let $L.A \longrightarrow m.B + n.C + \ldots$, etc, be the reaction, and let $a, b, c, \ldots$, etc., be the initial pressures of the molecular species $A, B, C, \ldots$, etc., and let x be the pressure of A transformed in time t. At time t the pressure of $A = (a-x)$, of $B = (b + m/l.x)$, of $C = (c + n/l.x), \ldots$ etc., A gas stream of varying composition bombards the surface during the reaction, and the probability that a molecule A will hit a centre of activity immediately it becomes bare is given by the fraction of A molecules in the bombarding stream, *i.e.* by

$$\frac{\mu_A(a-x)}{\mu_A(a-x) + \mu_B(b + m/lx) + \mu_C(c + n/lx) + \ldots}, \qquad (a)$$

where μ_A, μ_B, μ_C are constants depending on the nature of the gas.

If $\tau_A, \tau_B, \tau_C, \ldots$, etc., represent the mean lives of the molecules $A, B, C, \ldots$ on the centres of activity which are assumed in the present argument to be homogeneous, ξ be the fraction of a given time interval t during which the centre is free of adsorbed molecules, and n be the number of molecules adsorbed during this time t, which number is equal to the number of times the centre becomes vacant, then the number of molecules of A that are present among the adsorbed molecules during t seconds

$$= \frac{n\mu_A(a-x)}{\Sigma\mu_A(a-x)}$$

and the time they occupy the centre is

$$\frac{n\tau_A\mu_A(a-x)}{\Sigma\mu_A(a-x)}.$$

Thus the fraction of the interval of t seconds during which the "centre of activity" is occupied by A is

$$\frac{1}{t}\,\frac{n\tau_A\mu_A(a-x)}{\Sigma\mu_A(a-x)}.$$

But
$$t = \xi + \frac{n\Sigma\mu_A\tau_A(a-x)}{\Sigma\mu_A(a-x)}.$$

Hence the fractional time during which the centre is occupied by the reactant becomes

$$\frac{\mu_A\tau_A(a-x)}{(\Sigma\mu_A\tau_A(a-x) + \xi/n\Sigma\mu_A(a-x)}. \qquad (b)$$

If k be a constant depending on the number and nature of the centres of activity present, then at constant temperature the rate of reaction may be calculated from the fractional times of occupation.

L-molecular Reaction.—The rate of reaction is proportional to the probability that l adjacent centres should be occupied simultaneously by the reactant. Thus

$$\frac{dx}{dt} = k \prod_{1 \longrightarrow l}\left(\frac{\mu_A\tau_A(a-x)}{\Sigma\mu_A\tau_A(a-x) + \xi/n\Sigma\mu_A(a-x)}\right) \qquad (1)$$

$$= k \prod_{1 \longrightarrow l}\left(\frac{\alpha(a-x)}{1+\beta x}\right) \quad . \quad . \quad . \quad . \quad . \qquad (2)$$

or
$$kt = \int_0^x \prod_{1 \longrightarrow l} \frac{1}{\alpha}\left(\frac{1+\beta a}{a-x} - \beta\right).dx,$$

where

$$\alpha = \frac{\mu_A\tau_A}{\Sigma\mu_A\tau_A a + \xi/n\Sigma\mu_A a}, \text{ and } \beta = \frac{\Sigma m/l\mu_B\tau_B - \mu_A\tau_A}{\Sigma\mu_A\tau_A a + \xi/n\Sigma\mu_A a}.$$

If $\xi/n\Sigma\mu_A a$ be independent of x, then the general solution is

$$k = \frac{A}{t}\log_e\frac{a}{a-x} + \frac{Bx}{t} + \frac{C}{t}\left\{\frac{1}{a-x} - \frac{1}{a}\right\} + \frac{L}{t}\left\{\frac{1}{(a-x)^{l-1}} - \frac{1}{(a)^{l-1}}\right\}, \qquad (3)$$

where A, B, C, . . . are constants. The special case $\beta = 0$ becomes

$$k = \frac{1}{(l-1)\ t \prod\limits_{1 \longrightarrow l} \alpha}\left\{\frac{1}{(a-x)^{l-1}} - \frac{1}{a^{l-1}}\right\} \qquad (4)$$

and is of the form followed by homogeneous reactions.

Uni-molecular Reaction.—In the great majority of surface actions the effect of the catalyst is to simplify the reaction, lower the heat of activation, and make the change uni-molecular. The general relation becomes

$$\frac{dx}{dt}=\frac{K(a-x)}{1+\beta x}, \quad . \quad . \quad . \quad (5)$$

and, when K and β are independent of x, integrates to

$$K=\frac{1+a\beta}{t}\log_e\frac{a}{a-x}-\frac{\beta x}{t}, \quad . \quad . \quad (6)$$

where

$$k=\frac{\mu_A\tau_A k}{\Sigma\mu_A\tau_A a+\xi/n\Sigma\mu_A a}, \text{ and } \beta=\frac{\Sigma m/l\mu_B\tau_B-\mu_A\tau_A}{\Sigma\mu_A\tau_A a+\xi/n\Sigma\mu^A a}.$$

The form of (6) varies markedly with the values of the constants, and the majority of the forms it can assume have been experimentally verified by Hinshelwood and co-workers in their experiments on the decomposition of gases on hot wires. I have repeated the experiments on the decomposition of nitrous oxide and ammonia by platinum, and find good agreement with (6). The dehydrogenation of ethyl alcohol by copper in closed vessels also follows this equation. It is to be observed that it is now unnecessary to assume that the surface is saturated to obtain relation (6). F. H. CONSTABLE.

St. John's College, Cambridge,
January 15.

Discovery and Dialectics.

PROF. MASSON, in NATURE of January 2, courteously dissents from the conclusions expressed in my "Science and Scientists in the Nineteenth Century," and, thanks to the courtesy of the editor, I am allowed to reply.

My proof-sheets were revised by seven Cambridge fellows, who were kind enough to give me the benefit of their accurate knowledge in the different departments of science with which I deal. In addition to them, Sir A. E. Shipley, Sir J. J. Thomson, Sir Joseph Larmor, and Sir Oliver Lodge read through my proofs and made many helpful suggestions. The last, in his Introduction, expressly agrees with my conclusion that there are every whit as many prepossessions in science as there are in theology. The warfare between science and theology is, therefore, in no wise unique; for a similar warfare is characteristic of *every* form of human knowledge.

This is my main thesis, and Prof. Masson does not seriously attack it. He does, however, dissent from my conclusion that men of science do not receive new ideas with enthusiasm, suggesting that if they oppose them they are the rank and file of the scientific army. Let us take, therefore, two outstanding contributions to knowledge, the conservation of energy and the evolution of species. Joule performed not merely one experiment but many experiments, and a man of the standing of Kelvin points out that scientists like Graham or Miller objected to the results of these experiments, saying "simply he did not believe in Joule because he had nothing but hundredths of a degree to prove his case by." Mohr, Mayer, and Helmholtz shared the keen hostility Joule encountered. Gustav Magnus warned Helmholtz against undue partiality for mathematics, and the attempt to bring remote provinces of physics together by its means. Poggendorf thought that the paper of Helmholtz on the conservation of energy was not worth publishing in the *Annalen*. The older physicists, like Dove and Reuss, would not admit the principle of the conservation of energy. Distinguished mathematical colleagues like Eisenstein and Lejeune-Dirichlet seconded the opposition of Dove and Reuss.

Darwin succeeded in obtaining the qualified approval of Lyell, Hooker, and Huxley to his illuminating conception. With these three signal exceptions, it is true to say that the leading men of the world of science offered the stoutest opposition to his ideas. Sir Richard Owen was a naturalist who occupied such a foremost position in science that he has been called the British Cuvier, and he could not see his way to accept the new view. Among the opposition were W. H. Harvey, J. H. Balfour, H. Falconer, Sir E. Sabine, H. C. F. Jenkin, St. G. J. Mivart, A. Gray, L. J. R. Agassiz, J. L. A. de Quatrefages de Bréau, G. A. Brullé, F. J. Pictet, J. H. C. Fabre, Henri Milne-Edwards, O. Volger, R. A. von Kölliker, and K. E. von Baer. The bulk of the criticisms given in my book appeared almost immediately after the publication of the "Origin of Species," and, I do not think that I have given any criticism of later date than the year 1864, within five years of its appearance. These critics leave on the mind of the candid reader the impression Huxley took the trouble to record in 1887: "There is not the slightest doubt that, if a General Council of the Church scientific had been held at that time (*c.* 1860), we should have been condemned by an overwhelming majority." In 1885 he wrote: "It is curious now to remember how largely at first, the (scientific) objectors predominated."

ROBERT H. MURRAY.

Broughton Rectory,
Huntingdon.

DR. MURRAY'S reply to my review makes me feel, like the Elephant's Child, "a little warm, but not at all astonished." For I have not been taken literally, and I wished to be. Nor, I think, has Sir Oliver Lodge; for, whatever opinion the words of his "Introduction" may cover, in them he most certainly does not "expressly agree" that science is as full of prepossessions as is theology; he presents Dr. Murray's conclusion and its consequence, but his personal verdict on the question of equality is withheld. So far am I from dissenting from Dr. Murray's statement that new ideas are not enthusiastically received in the scientific world, that I was at pains to emphasise this fact, and went further by asserting that this coldness plays an indispensable part in the method of science by counteracting hasty belief. That Dr. Murray neglects the fundamental value of decent scepticism is my main quarrel with him. Please, I did not suggest that only the rank and file pooh-pooh new ideas! I expressly included every one. In doing so, I propounded an idea, and Dr. Murray has unkindly blighted it by neglect; I said, "Moreover, no man of science, not even the greatest, has more than a short period in his life during which he is so free from human vanities that his discoveries are faultless and his opinions just." Dr. Murray implies that I called Joule's work "one experiment"; I said "one research."

I shall not, I hope, be thought guilty of impatience if, for the sake of saving space, I close by referring any one who wishes to concern themselves in these matters (*a*) to the literal sense of my article of January 2, (*b*) to Sir Oliver Lodge's Introduction to (*c*) Dr. Murray's well-founded facts about men of science, and (*d*) to Dr. Murray's natural, but—I am sorry!—fallacious inferences about science.

IRVINE MASSON.

Genes and Linkage Groups in Genetics.

I HAVE no intention of criticising in detail the elementary lecture on Mendelism which Prof Huxley gives in NATURE of January 30, p 154, as a supposed reply to my remarks in the issue of December 26, 1925 Our minds are so differently constituted that what he regards as facts I consider to be unproved assumptions, and what he calls proof I consider to be begging the question Nothing of what he says is new, indeed much of it, it has been my painful duty to present to my students year after year whilst never concealing from them my utter scepticism as to the assumptions involved.

Prof. Huxley's statistics leave me entirely unmoved Statistics in biology are a very dangerous weapon; their value entirely depends on the validity and definable character of the *unit* which is counted It is because I do not regard Morgan's units as having any validity whatever that I consider his deductions as valueless. These units are avowedly assumed in order to make his observations fit a preconceived theory, if the fit is not exact, then further units will be assumed in order to make the fit better, and this procedure he calls proof

I should like, however, a brief space to set forth to readers of NATURE the reasons why, in company with some of my most distinguished colleagues, I regard the whole of this "factorial analysis" as both formal and futile.

In the first place, the supposed "genes" or "unit factors," even if we concede their existence, throw no light whatever on the course of evolution or on the past history of existing species This is the opinion of those whose opinions are most entitled to respect in the realms of systematic zoology, of palæontology, and of embryology, which are the three great sources of our knowledge of evolution What is the use of telling us that the constitution of an animal is to be represented by the factors *a*, *b*, *c*, *d*, *e*, *f* and *g*, if it was not formerly represented by *a*, *b*, *c*, *d*, *e* and *f*, and has become what it is by the addition of "*g*"?—Yet when we examine in detail what the "factors" in Drosophila actually are, any competent entomologist would laugh to scorn the idea that they represent elements in the evolution of an actual insect. Secondly, what Morgan has proved in the case of Drosophila and what has been shown to occur in every case where plants are cultivated or animals bred in confinement in large numbers, is that sharp deviations from the type occur and that these aberrant individuals when crossed with the type exhibit Mendelian segregation in their inheritance So universally is this the case that geneticists like Baur have been driven to assume that there must be "idiokinetic factors" in the environment to account for these mutations

Now if the true object of science is *rerum causas scire*, once this fact has been well established, the next step should be to ascertain how the distinctive features of these mutations are acquired in the course of individual development and whether apparently unrelated mutations might not be due to varying intensities of the same disturbance of embryological processes As I pointed out in the review which originally excited Prof Huxley's criticism, we can show in the case of Vertebrata that "mutations" as apparently diverse in nature as mental defect and supernumerary fingers can be explained as due to varying degrees of abnormal amniotic pressure Yet we look in vain in the work of the Morgan school for any trace of analysis of this sort

Thirdly, when the course of individual development has been ascertained, the next step should be to try to find the environmental influences which have produced the disturbances of development. It is because Tornier has done this and has brought a great mass of direct and indirect evidence in support of his views that I regard his work as equal in value to that of all the other geneticists put together Not only has he shown how mutations arise, but he has also thrown light on the still more interesting question of why these mutants when exposed to natural conditions tend to revert to type. This valuable work is of course only in its initial stages like other pieces of important work, its course was interrupted by the War and has not been since resumed, but it is only along lines such as these and not by the assumption of imaginary factors that a ture explanation of the origin of mutations and of the physiological nature of Mendelian inheritance will ever be attained

E W MACBRIDE.

Greenland or Polar Front.

To Mr L C. W Bonacina's communication entitled "Greenland or Polar Front," which appeared in NATURE of November 21, p 748, I should like to make a brief reply I must again insist upon the contrast which exists between the two polar regions of the earth,[1] and repeat that, despite much misconception, the Arctic basin is neither cold nor dry relative to Greenland or, during the cold season, even to Siberia and British America Nansen's observations made during the drift of the *Fram* show that 66 5 days in the year were foggy Mr Bonacina's statement that fogs did not occur during the winter, does not refer to the long cold polar season, but to the short period of December to February inclusive Fogs occurred in every other month, and one day in every four was foggy for this period During Capt Amundsen's flight toward the Pole, fogs were so thick that little could be seen for much of the way, and near 89° N fogs were a serious handicap in taking off after the forced landing

Mr Bonacina urges in support of a supposed cold high-pressure "polar front" a pressure difference between the Arctic basin and the Icelandic low, but it is significant that within this very sector of the Arctic basin the dominant wind component along the meridian is not from the north, but from the south Mohn's tables based upon Nansen's observations on the *Fram* for the year 1895 (when the vessel zigzagged throughout along the 85th parallel of latitude within the European sector) showed that for the entire year 59 4 per cent. of the wind force had a southerly component and only 40 6 per cent a northerly Reckoned for the periods November to April and May to October separately, the corresponding figures are for the southerly component 58 1 per cent and 60 5 per cent respectively For the short winter season (December to February) when fogs were not observed and when, according to Mr Bonacina, it might be supposed that cold air would move out southward from the Arctic basin, no less than 63 2 per cent. of the wind component reckoned along the meridian was from the south[2] As pointed out in my earlier communication to NATURE, the most striking fact which emerges from all the *Fram* observations is their monotony of character with but slight seasonal changes—these are the well-known characteristics of an expanse of sea.

The course of the *Fram* as it drifted in the ice supplies an even more striking proof that the dominant winds over the Arctic basin do not move outward, but, on the contrary, inward. The wind components throughout have been computed by Mohn, and these appear strikingly set forth upon two of his charts.[3] Evidence has piled up along the same direction from stations on the Arctic coasts of Siberia and British America for the long winter season, during which winds from the north are accompanied by elevation of temperature and those from the south by a fall of temperature. Kindle, with much personal experience in Arctic America, has rendered a service through assembling the observations to prove this generalisation.[4]

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[1] William Herbert Hobbs, "L'asymétrie de la circulation atmosphérique," *Comptes rendus de l'Acad. des Sciences*, t 181, 17 août 1925, pp 289-290

[2] H Mohn, "The Norwegian North Polar Expedition 1893–1896, Scientific Results," London, vol. 6, 1905, p 315

A more complete answer to the objections raised by Mr. Bonacina will be found in a monograph now in press and soon to be obtained through the General Library of the University of Michigan.[5]

William Herbert Hobbs

The Palæolithic Drawing of a Horse from Sherborne, Dorset.

In entitling his account of this object "On an *apparently* Palæolithic Engraving on a Bone from Dorset" (my italics) Sir Arthur Smith Woodward displayed his habitual caution, and it is with great regret that I now find myself obliged to differ from one for whose judgment I have so great a respect. For I still believe the Sherborne drawing to be a forgery and a clumsy one at that. It was perpetrated as a practical joke, such as delight the heart of boys of fifteen. How far the finders of the bone were involved in the affair there is nothing to shew, one or other of them may have been innocent of it. But that some of the boys in the school were not quite so ignorant as Mr. Araldo Cortesi professes himself to be is shown by the fact that they were familiar with "Early Man in Britain" and the illustration of the Creswell Crag horse given there by Sir W. Boyd Dawkins.

Mr. Bayzand, who was intimately acquainted with all the facts—which he communicated to me—acutely remarks that a tracing of the Sherborne drawing when superposed on that of Creswell reveals an identity in size and as well a remarkable correspondence in outline. The odds against such a correspondence arising as a mere coincidence are sufficiently great, but it is easy to understand how a tyro in the art of forgery would have found it difficult—unless he happened to be a skilled artist—to make a sufficiently plausible copy with a change of scale. Further, those parts of the Sherborne copy which differ from the Creswell original do so in just those details which are likely to betray the inexperienced observer.

I do not fully understand the term "semifossilised," but I imagine it is intended to mean less altered than the mammalian teeth found in the gravels of the neighbourhood, *i.e.* in just such a state as might be expected of a bone which had lain in a refuse heap exposed to the air.

W. J. Sollas.

University Museum,
Oxford, January 22.

Prof. W. J. Sollas has directed my attention to a letter in the issue of Nature of January 16, by Sir Arthur Smith Woodward, on the supposed Palæolithic drawing of a horse from Sherborne.

At the time of the "discovery" of this drawing I was engaged at the Sherborne School in arranging the museum collections and then learnt something of the history of the find.

The whole affair, as I gathered, was a trick played solely for the benefit of the science master without any idea that it would go any further. Its success was a source of much merriment at the school, particularly amongst those boys who were under this master, and I was even invited by some to inspect the fake.

I may mention that a copy of "Early Man in Britain" was lying in the Museum while I was there, and I should add that I was informed that the bone was discovered near a rubbish heap on the Bristol road, where some of the refuse of the town had been deposited.

This, so far as I can remember, was in the year 1912 or 1913, and I dismissed the whole matter from my mind until I learnt, not without surprise, that Sir Arthur Smith Woodward had communicated the "discovery" to the Geological Society. When later I read his account I at once informed Prof. Sollas of all that I knew, and so am directly responsible for the statement made by him in the third edition of "Ancient Hunters."

C. J. Bayzand.

Oxford, January 21.

Spermatogenesis in Spiders and the Chromosome Hypothesis of Heredity.

Prof. Warren, in Nature, January 16, writes a second letter in support of his previous contention that the spermatogenesis of spiders is different from that of all other animals, and that it is "a good corrective to the view of the all-sufficiency of chromosomes, and to the tendency to substitute cellular structure in the place of the directive vital activity of the organism."

It is difficult to understand what Prof. Warren means by this statement, because it is universally allowed that modern cytological observations have thrown a clear light on nearly every problem of genetics and heredity.

In the past ten years I have probably carried out more investigations than any one else on the cell cytoplasm and its organellæ, yet throughout I have been obliged to admit that the only cell organs which fulfil the necessary conditions which a study of genetics lays down, are the chromosomes.

At the same time, while I have been forced to believe the chromosome theory in general, I recognise clearly that there are still many facts which the chromosome theory does not explain. The spermatogenesis of spiders, as we know it in this laboratory, provides no stumbling-block to a belief in any part of the chromosome theory, any more than does the presence of atypic spermatozoa in molluscs, for example.

The amitosis question has long been a subject which the anti-chromosome theorist has toyed. Prof. Warren is not the first rebel, he will not be the last. When I was a student at Oxford I caused some concern to my teachers by developing a bad attack of amitosis-itis. It was brought on by reading Prof. Child's interesting paper on "Moniezia." However, that is "past history."

Now Prof. Warren is in the middle of a bad attack of the same disease. Like all the evidence for amitosis in germ cells, Prof. Warren's is going to be unconvincing. Even if this investigator does demonstrate division or fragmentation of nuclei, this does not necessarily mean that the cell is dividing amitotically. I can only refer Prof. Warren to Macklin's paper in the Carnegie Institution of Washington, Series, Embryology.

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[3] *Op. cit.*, vol. 3, pls. xviii and xxviii.

[4] E. M. Kindle, "Observations on Ice-borne Sediments by the Canadian and other Arctic Expeditions," *Am. Journ. Sci.*, vol. 7, April 1924, pp. 253-257.

[5] William Herbert Hobbs, "The Glacial Anticyclones, the Poles of the Atmospheric Circulation," *University of Michigan Publication*, Ann Arbor, Mich., pp. 200, 3 pls., 53 text figures. 3 dollars.

If the chromosome theorist can demonstrate one normal mitosis in Prof. Warren's slides, the whole of this observer's claims must be in doubt. The onus lies with Prof. Warren, and not with the chromosome theorist. The atypic sperms of molluscs have been followed even into the egg; no cytologist could sustain an attack on the chromosome theory when we know that the typic sperms of these molluscs are the real agents in fertilisation.

As was reported in NATURE in October 17, 1925, Dr. S. D. King examined one species of spider, and found a normal chromosome cycle in certainly a vast majority of the cells. In fact, I have never seen a bigger X-chromosome Now, we know from Dr. King's work that a normal chromosome cycle may occur in spiders, with normal spermatogonial divisions and normal spermatogonial spindle-bridges, so we must hesitate in accepting Prof. Warren's statements so far as they constitute an attack on the chromosome theory.

Prof. Warren seems to have been the first person to have shown that peculiar atypic spermatogenesis may occur in spiders, and for this he deserves much credit.

J. BRONTË GATENBY.

Zoological Laboratory,
Trinity College, Dublin,
January 19.

Polyploidy and Sex Chromosomes.

THE interesting announcement of Dr. J. W. Heslop Harrison (NATURE, January 9, p. 50) that he has found a single pair of sex chromosomes in certain polyploid species of Salix will, if confirmed, add to our knowledge of sex chromosomes in diœcious plants, but does not necessarily alter any of the current views regarding the origin of polyploidy. The fundamental fact that the chromosomes in many plant genera occur in arithmetical series, shows that the process of multiplication in number is one that affects all the chromosomes simultaneously. This is true however the change comes about, whether, for example, through a suspended mitosis or by the union, in hybridisation, of nuclei the chromosomes of which are sufficiently incompatible to be unable to pair in the following meiosis. Multiplication of the whole chromosome series through a condition involving a suspended mitosis is well known to occur naturally in various plant tissues and has been produced experimentally by a variety of methods.

There has been evidence for many years, for example, in the genetic behaviour of *Oenothera gigas*, that secondary changes took place in addition to the primary doubling of the chromosome number, such changes being either coincident with or subsequent to the original doubling. The hypothesis ("Polyploidy," 1924, *Brit Journ. Exp. Biol.*, vol. 1, p. 175) that the hexaploid condition in wheat has arisen through the crossing of a diploid with a tetraploid species, producing a sterile F_1, in certain individuals of which a split in the chromosomes gave all the chromosomes mates and so produced a fertile hexaploid individual, has recently been fully confirmed experimentally (Clausen, R. E., and Goodspeed, T. H., "Interspecific Hybridisation in Nicotiana," *Genetics*, vol. 10, p. 278, 1925). In a cross between *Nicotiana tabacum* var. (diploid, $n=12$ chromosomes) and *N. glutinosa* (tetraploid, $n=24$ chromosomes) they obtained a sterile F_1 with $3n$ (36) chromosomes. A single capsule, however, produced from seeds two plants, one of which was fertile and when selfed produced an F_2 population like the F_1 but somewhat larger in size. These were shown to be hexaploid ($2n=72$), although the authors speak of it as a tetraploid form.

This removes any possible doubt about such processes actually taking place and affecting all the chromosomes simultaneously. If a single pair of sex chromosomes occurs in a hexaploid species of Salix, it would mean that an additional process of adjustment has taken place, the nature of which might be disclosed by further investigation. There is evidence that secondary changes have taken place in the chromosomes of certain polyploid species. The size relationships of chromosomes and nuclei in the Salices have already shown that some peculiar conditions are involved, and these may well be concerned in part with the readjustment of the sex chromosome mechanism.

Two further points must be briefly stated in this connexion. (1) Bridges (*Amer. Nat.*, vol. 59, p. 127) has recently obtained tetraploid females of Drosophila with 4 sex chromosomes, showing that the X-chromosomes have been duplicated at the same time and in the same way as the autosomes. (2) The situation which Dr. Harrison mentions has already been described (Santos in *Bot. Gaz.*, vol. 75, 1923) in Elodea. This is tetraploid in comparison with related forms, having 48 chromosomes including an unequal XY pair. Meurman (*Soc. Sci. Fennica, Comm. Biol.*, 2, 3) has also recently given reasons for suggesting that *Rumex acetosella* ($n=20$-21) is a ditriploid species. It has a single pair of sex chromosomes and another pair which are transitional in behaviour between sex chromosomes and autosomes. These are further reasons for believing that sex chromosomes duplicated in the process of tetraploidy can later be gradually transformed into autosomes.

R. RUGGLES GATES.

King's College, London, W.C.2,
January 12.

The Magnetic Storm of January 26-27, 1926.

THE great increase in solar activity since the middle of November last, as manifested by spots and faculæ, was not accompanied by any notable magnetic disturbances until January 26, when the greatest storm of the present solar cycle was recorded.

There is some ground for considering this storm as one of a sequence of disturbances at approximately 27-day intervals, extending with only three interruptions since March 5, 1925, but this is not yet definitely established.

There was a small "Sudden Commencement" at $17^h\ 30^m$ on January 25, but it is uncertain whether this should be associated—except as a premonitory symptom—with the storm proper, which may be considered as beginning on January 26, with pronounced movements in both D and H at $15^h\ 30^m$. The general character of the disturbance followed a normal course, with an extreme range in D of 74′, and in H of 660γ.

An interesting feature of the H record was a periodicity in the recurrence of maxima in the first phase of the storm. Four conspicuous maxima were found to be spaced at intervals of exactly 54 minutes, whilst midway between the last two was the highest maximum of the storm. Further examination of the curve suggested the superposition of two periodicities of about 18 and 27 minutes respectively. This was tested by measuring the times of all the more obvious maxima in this portion of the curve, when it was found that during a period of three hours there was a maximum corresponding to every integral multiple, from 0 to 10, of 18^m, whilst all the principal maxima corresponded to integral multiples of 27^{m}, and all except the greatest, to the concurrence of integral multiples of both periods. This exception may seem to vitiate the whole conception of the double periodicity suggested, but the objection disappears when it is remembered that an impulse may be periodic without its amplitude factor being a constant, and it only requires a suitable adjustment of the values of these factors for the maximum of the 27 minute period to more than neutralise at this one point the minimum of the 18 minute period. There are also many other oscillations of short period present which must necessarily modify the absolute values of maxima.

This double periodicity may be accounted for, if we suppose the magnetic disturbances to be due to ionic emissions from the sun, propagated in rays with approximately equal spacing, whilst the density of the ions varies in a periodic manner, in shells along the rays, owing to a pulsating or rhythmic emission from the disturbed region on the sun. In this way the orbital motion of the earth, entering the successive rays, would account for one period, whilst the arrival of successive shells at the earth's position would account for the other, and variations in the degree of concentration in both rays and shells would account for any variations in amplitude, as well as for the presence of minor oscillations concurrently with those presenting the more conspicuous features of the record.

J. P. Rowland, S.J.

Stonyhurst College Observatory,
Blackburn.

Use of Interference Methods in the Determination of Stellar Diameters.

Referring to the article on the work of Prof. Michelson in Nature of January 2, it is interesting to note that the first suggestion as to the application of interferential methods to the determination of the angular diameter of stars appears to have been made in 1868, being due to Fizeau, and that the method was actually put to the test in France—although with negative results—seventeen years before Prof. Michelson's paper of 1910 referred to by Sir Oliver Lodge. Pointing out a relation between the width of the interference bands and the dimensions of the source of light, Fizeau added this pregnant remark: "It is perhaps permitted to hope that by taking this principle as a basis, and in forming, for example, by means of slits wide apart, interference fringes at the faces of large instruments intended for stellar observations, it will become possible to obtain some new data on the angular diameter of the stars" (*Comptes rendus*, 5, 66, 1869, p. 934).

In the absence of any telescope of sufficient size, this suggestion was bound to remain barren for more than fifty years, but the method was nevertheless actually used in Marseilles in 1873, by Stephan, with a telescope of 0·80 metre aperture, for the purpose of measuring stellar diameter. The aperture was, however, too small, and Stephan had to be satisfied with ascertaining that the apparent diameter of stars of the first magnitude, including Sirius, is less than 0·158″ (*Comptes rendus*, 5, 76, 1873, and 5, 78, 1874, p. 1008).

The first successful application (to the measurement of the diameter of the satellites of Jupiter, of the order of about 1″) was made by Prof. Michelson in 1891, but, by an improvement of the method, Hamy in Paris measured in 1898 the apparent diameter of Vesta (0·54″).

As we all know, the prize fell finally to the hands of the American astronomers, thanks to the amazing self-confidence and tenacity of purpose, combined with almost superhuman skill, which rendered possible the adjustment of mirrors, some twenty feet apart, to an order of displacement comparable to the wave-length of light.

The fame of Prof. Michelson is so well established, and the results themselves are so striking and far-reaching, that the above acknowledgment of the efforts made elsewhere, sterile, it seems, only because of the modest equipment available, in no wise diminishes the glamour of the final achievement.

M. Gheury de Bray.

The Free Path of Slow Protons in Helium.

In the issue of Nature for December 19, p. 900, Dr. A. J. Dempster states that he has found that slowly moving protons pass almost freely through helium atoms without being neutralised. In this connexion it may be of interest to state that I have found in the course of experiments on the scattering of protons (hydrogen positive rays) by helium and other gases, that the scattering in helium is a maximum for rays of the energy of about 10,000 volts. For slower rays the scattering is less, and for rays of 3500 volts, the slowest examined, is about 75 per cent. of the maximum. While these rays are considerably faster than those used by Dempster (300 to 900 volts), both results are probably part of the same effect. This may be analogous to the abnormal penetration of very slow electrons through certain gases found by Ramsauer. The *velocities* of these electrons were about the same as those of the protons used by Dr. Dempster. The effect was most marked in argon, but also occurred in helium and neon.

Results on the scattering of protons in hydrogen, now awaiting publication, do not show this abnormality, the scattering increasing with decreasing energy of the rays, though less rapidly than would be expected if the scattering were due to forces of the inverse square type. Experiments on argon are in progress.

G. P. Thomson.

University of Aberdeen,
January 20.

Residual Ionisation in Closed Vessels.

Experiments have frequently been carried out to determine the residual ionisation in closed vessels, and to reveal the conditions under which this is a minimum. One of the lowest values hitherto measured is that of McLennan and Murray, who made their measurements over Lake Ontario, using an ionisation chamber of ice. They obtained the value $q=2{\cdot}6$ pairs of ions per c.c. per second.

It seems to have escaped notice that K. Bergwitz ("Elster-Geitel Festschrift," p. 585 (1915)) has made measurements in rock-salt workings in Germany, when he found the exceedingly small value of $q=0{\cdot}8$.

The value of the residual ionisation has a significance in connexion with estimates of the contribution of the penetrating nebular γ-radiation to atmospheric ionisation, and I have not seen a reference to Bergwitz' result in recent publications on this subject. This is undoubtedly due to the fact that the above-mentioned publication is not so well known as it deserves to be. It commemorates the sixtieth anniversary of those two distinguished and inseparable German scientists, Elster and Geitel, and contains many valuable contributions to radioactive literature.

Robert W. Lawson.

The University,
Sheffield.

Light Waves and Light Corpuscles.

By Prof GILBERT N. LEWIS, University of California.

THE theory that light is a series of spherical waves progressing from the source with velocity *c*, and the theory that light is a group of corpuscles moving in straight lines from the source with velocity *c*, have seemed mutually incompatible. Yet we must inquire whether this apparent incompatibility may not be due to some error in our traditional modes of thought, for no prediction of either of these two theories has yet failed to be confirmed. Indeed, we have reached the point where it seems justifiable to summarise a part of our information regarding light in the following manner.

LAWS OF THE CORPUSCLE

Recent experiments, especially those of A. H. Compton, have fully corroborated Einstein's brilliant surmise that the energy of radiation consists of quanta. Thus the energy lost by an emitting atom travels as a discrete particle along a single continuous path with the velocity *c*. This path is a straight line, except for deflexions in the immediate neighbourhood of another mass In the process of deflexion the particle of light and the other mass both obey in detail the laws of conservation of energy, mass, and momentum. If in Fig. 1 a corpuscle of light proceeds from *S* to a mirror at *A* and then to an absorbing screen at *D*, we are convinced that the time required for the corpuscle to pass from *S* to *D* is very nearly the length of the path *SAD* divided by *c*. But we are also convinced that the corpuscle never moves with a higher velocity than *c*, and therefore its path must be very nearly the two straight lines *SA* and *AD* This law of the rectilinearity of the path will be very important in our further discussion.

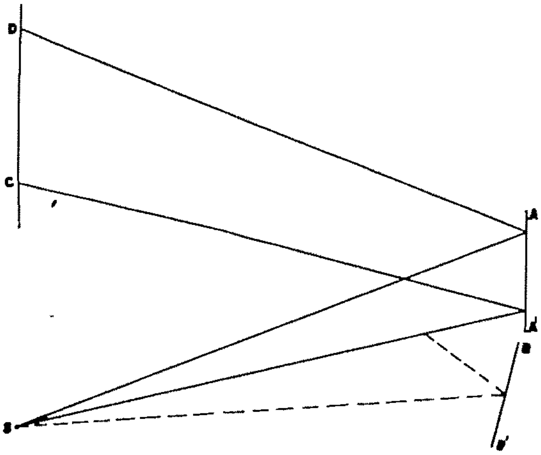

FIG 1

LAWS OF INTERFERENCE.

The classical laws of interference maintain their full validity no matter how weak a source of light is employed. Thus if we should set up an optical apparatus to give light and dark interference bands upon a screen, even if the source of light were so extremely weak as to give only one atomic emission per hour, yet in course of time a photographic plate placed at the screen would show the typical bright and dark bands. The phenomenon of interference can, therefore, in no way depend upon any mutual interaction of a number of quanta, but each quantum by itself must obey, at least statistically, the laws of interference

Let us suppose that the optical apparatus consists of a pair of Fresnel mirrors, as shown in Fig 1. *S* is the source of light, and *AA'* and *BB'* are two mirrors producing interference bands on the screen *CD*. Now if the emitting source *only* sends out quanta, some of which reach the screen by way of one mirror and others by way of the other mirror, it would be impossible to understand how the presence of one of the mirrors could affect the paths of the quanta reflected by the other mirror. We are, therefore, led irresistibly to the conclusion that the phenomenon of light cannot be completely described as an emission of discrete quanta of energy. In addition to this, there must be something which may provisionally be called an interference field, perhaps existing even at times when the transfer of energy is not occurring, which determines where the emitted corpuscles will be absorbed.

This idea that radiation must be resolved into its two aspects, one relating to an interference field and the other to an actual transfer of energy, has been advanced by Slater,[1] and later by Swann,[2] both of whom assume that the emitting atom produces a sort of "virtual" Poynting vector, that the corpuscle of light can travel only along the path of a Poynting vector, and that the intensity of the Poynting vector determines the probability that a quantum will travel by a given path.

This explanation, however, encounters difficulties, of which the chief one is that in the region of interference the path of the Poynting vector is not a straight line but a wavy one, and a corpuscle forced to travel along this path would be quite appreciably retarded. Thus the law of the linear path excludes the possibility that quanta follow the Poynting vector

Nevertheless, if we are to admit that the quanta travel from source to mirror and from mirror to screen in straight lines, the angle of incidence being equal to the angle of reflection, we are led to certain conclusions which at first sight seem absolutely indefensible. If the mirrors are so arranged that the point *C* lies in the centre of a dark band, then no quanta will start from the source in the direction *SA'*. But suppose that *S* is a distant source, and that the quanta are on their way before the mirrors are set up, how can the presence of the mirror *BB'* prevent the light corpuscles already on their way from *S* to *A'* from reaching the forbidden spot *C*? Do the emitting atoms know *in advance* how the mirrors are going to be arranged, and refuse to emit in the directions which would lead to the dark bands? Or, in other words, can we, by setting up such a simple interference system, alter a past event, such, for example, as a star's emission of a quantum in a certain direction some thousands of years ago? Such a thought is repugnant to common sense, and yet, absurd as it may seem at first sight, it is essentially the theory which I now wish to propose. I shall attempt to show that such a theory requires only a slight extension of the idea of physical time introduced by Einstein, and that it leads to a far better agreement between physical concepts and the geometry which interprets so satisfactorily the kinematics of relativity. By way of introduction, let us consider briefly the meaning of time in the physical sciences.

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[1] Slater, NATURE, 113, 307 (1924)

[2] Swann, *Science*, 61, 425 (1925)

THE IDEA OF TIME IN PHYSICS.

There is some discrepancy between the equations of mathematical physics and the less formal physical explanations with which we are accustomed to annotate them. The equations themselves recognise no distinction between positive and negative extension in time; they are symmetrical. But, in the language of physics, a great distinction is made between past and future. Yet the eclipses of a thousand years ago are calculated with just the same precision as those of a thousand years hence, and (except for slight tidal action) a moving picture of the solar system, if the film were run backward, would show a system equally in accord with the laws of Kepler, Newton, and Einstein.

In daily life we constantly recognise the uni-directional character of time, but here we deal with far greater complexity than is found in the simple systems of physics and chemistry. Is it necessary or useful in these sciences to assume any dissymmetry between past and future?[3] At first we should be inclined to say that there must be such dissymmetry in the so-called irreversible processes, but Gibbs and Boltzmann have taught us to regard these merely as an enormous number of elementary processes, each of which obeys simple mechanical laws.

However, the idea that elementary processes, involving only a few atoms or molecules, are in all respects reversible, has never been fully accepted; for while it is admitted that the motion of the atoms in their collisions with one another may be perfectly reversible, it has seemed that the process of *radiation*, even from a single atom, must be irreversible. Indeed, so long as it was supposed that a radiating atom sends out energy in all directions, there seemed to be no way of regarding such a process as reversible. But we now know that this is not the case, and in advancing the theorem of 'entire equilibrium,' I have recently shown[4] how we may consider all these elementary processes as completely reversible and symmetrical with respect to past and future. We thus arrive at the view that a corpuscle of light is shot out from an atom, as an electron may be ejected; that this corpuscle then travels about and later reaches another atom where it is absorbed, by a process which is the exact reverse of the process of emission. I desire now to go much further than this, and to point out an essential difference between the emission and later absorption of an electron and the emission and absorption of light. Here it will be necessary to recall some of the salient features of the geometry of relativity.

THE GEOMETRY AND THE PHYSICS OF RELATIVITY.

The new kinematics is so admirably represented by the geometry introduced by Minkowski[5] that we should spare no effort to secure harmony between the ideas of this geometry and the concepts of physics. Let me first point out how absurd it would be in any geometry to find a theorem true for a given figure, but false if the figure were turned upside down. In showing that all processes, including radiation, are perfectly symmetrical with respect to past and future, an important step has been taken toward reconciling our physical and geometrical ideas.

Next it may be noted that radiation occupies a unique position in kinematics. In the two-dimensional geometry of relativity, illustrated in Fig. 2, there are two singular lines through a point O, namely, OL and OL', which separate all of the space-like lines, such as OX and OX', from all time-like lines, such as OT and OT'. The singular lines occupy an intermediate position and belong no more to one class than to the other. Now a line such as OT or OT' may be regarded as a locus in space-time of a particle, but lines such as OX and OX' can have no such interpretation. When we associate the singular line OL with the time-like lines, and say that it represents the motion of a light particle, we are forsaking the symmetry of the geometry as a concession to certain habits of thought. If we continue to make this concession, it must be met with a realisation of the unique character of the radiation process.

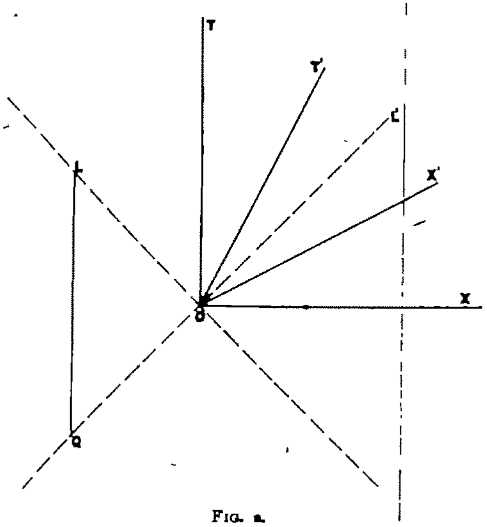

FIG. 2.

It is characteristic of this geometry that any interval such as OL, along a singular line, is said to have zero length, and this is an idea of which much use has been made in the mathematics but none in the physics of relativity. Let us now say that if OT and QL represent the loci of two atoms, then any pair of points, such as O and L or O and Q, which are separated by zero distance are in ***virtual contact***. In other words, I may say that my eye touches a star, not in the same sense as when I say that my hand touches a pen, but in an equally physical sense.

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[3] This is a subject which I have discussed at some length in the recent Silliman Lectures, which will be published shortly by the Yale Press.

[4] *Proc. Nat. Acad. Sci*, 11, 179 (1925); 11, 422 (1925).

[5] This geometry has been worked out in some detail by Prof. E. B. Wilson and myself, *Proc. Amer. Acad*, 48, 389 (1912).

A NEW CONCEPTION OF LIGHT.

It has been generally assumed that a radiating body emits light 'into space' regardless of whether there are near or distant objects which may ultimately absorb that light; but, so far as I am aware, the only evidence for this view is the qualitative observation that on a clear night objects radiate energy into what seems to be empty space. This, however, might merely indicate that there is a considerable amount of cold matter in the universe. It would be interesting to make some quantitative experiments in this direction.

I shall make the contrary assumption that an atom never emits light except to another atom, and that in this process, which may rather be called a transmission than an emission, the atom which loses energy and the atom which gains energy play co-ordinate and symmetrical parts.

When two molecules collide and one gives up an atom or an electron to the other, we think of the process as occurring without mediation of any kind, and so probably we shall eventually consider the exchange of energy between two atoms through virtual contact. But to adopt this view at once would be severing too abruptly all connexion with the historical views of physics. We therefore say that a corpuscle of energy travels with the velocity *c* from atom to atom, and that there is a field (a 'retarded' field if ascribed to the emitting atom, an 'advanced' field if ascribed to the receiving atom) which determines the probability of the interchange. The invention of the corpuscle of light and these fields permit us to express the process of radiation in conformity with our ordinary spatial ideas and with the laws of conservation.

However, if the theory that I propose is correct, it should later be possible to express the probability of an energy transfer merely as the degree of 'fit' between the emitting and absorbing atoms at their points of virtual contact. The great revolution in physical thought which resulted from Maxwell's electromagnetic theory of light made scarcely any change in the mathematical equations of optics; and it is also possible to derive the same equations in accordance with the new views which I am here advancing. How this may be done will be set forth in a series of papers in the *Proceedings of the National Academy of Sciences*, of which the first is now in press.

Before concluding, I may point out that there is a crucial experiment, apparently within the range of experimental feasibility, which should decide for or against the theory. In the apparatus described in Fig. 1, all previous theories of light would predict a practically constant radiation pressure over the mirror *AA'*. This is true of the theories of Slater and of Swann; for the Poynting vector is uniformly distributed over the mirror. But suppose that the mirror *BB'* is so adjusted that the point *C* is in the centre of a dark interference band, while the point *D* is at the centre of the next bright band. Then, according to the new theory, quanta are travelling by the path *SAD* but none by the path *SA'C*; therefore the pressure on the mirror will all be on the side *A*, and if the mirror is suspended at its centre it will experience a measurable torque.

Climate Changes in Western America.[1]

It is now more than ten years since Ellsworth Huntington first employed the growth rings of the Big Trees of California to demonstrate the existence of variations of rainfall during the past four thousand years. The chief difficulty has been the conversion of the curve of tree-growth into a curve of rainfall. Trees grow more rapidly when they are young than when they are middle-aged, while in old trees the growth becomes irregular, so that the equation connecting tree-growth and rainfall at the present day cannot be applied with safety to the early rings of the very oldest trees. Huntington, fresh from an investigation of climatic changes in western Asia, read into the tree-growth curve a close similarity to the fluctuations of level of the Caspian, and applied a "Caspian correction factor" to the curve of tree-growth. The early levels of the Caspian are themselves very problematical, however, and the extrapolation to Western America did not inspire confidence.

A more trustworthy control has now been supplied by the variations in the level of the salt lakes of the Great Basin in close proximity to the trees. It is well known that during the Pleistocene Ice Age the Great Basin was occupied by a number of lakes, of which the largest have been termed Lakes Bonneville and Lahontan. This was many thousand years ago, but some investigations carried out by J. Claude Jones into the salt content of Lakes Pyramid and Winnemucca, which occupy part of the old basin of Lake Lahontan, show that these lakes have been accumulating salt for a period probably between 2500 and 3000 years, so that at some date between 1000 and 500 B.C. they consisted of fresh water. A lake formerly salt may become fresh either by overflowing or by becoming dry for a period long enough for the salt deposit to be covered by a thick layer of detritus. There is no evidence that the lakes have ever overflowed, so that we must adopt the second alternative and suppose that a long dry period ended between 1000 and 500 B.C. If J. C. Jones had left the matter there he would have done much to assist the study of climatic changes, but unfortunately he has confused the deposits of the old Pleistocene lake Lahontan with those of the modern lakes, and has marred his work by some unwarranted statements as to the survival of the lion, horse, and camel in North America into historic times.

In the same publication, E. Antevs has made a thorough revision of Huntington's data of tree-growth, and has prepared a series of curves corrected for the various sources of error, from intrinsic evidence only. His various curves for damp and dry localities agree well among themselves and seem to establish the reality of the climatic fluctuations, though they still leave the absolute level of the early part of the record in some doubt. These curves point to a rapid increase of rainfall about 850 B.C. This evidently corresponds with the formation of the modern Lakes Pyramid and Winnemucca; about that date the rainfall must have increased from less to more than its present value, and we can adjust the level of Antevs' curves accordingly. Various other points can be determined from a study of the terraces formed during different stages in the history of these and other lakes; for example, the salt content of Owens Lake shows that it became fresh rather more than 2000 years ago, in this case by rising to such a high level that it overflowed, indicating that a peak on the corrected tree-growth curve at 450 B.C. was the absolute maximum of the whole curve. The age of Lake Walker is estimated as 800 to 900 years, and it can be shown that this lake originated with some changes in the drainage during a period of increased rainfall. A peak on the tree-growth curve fixes this maximum, second only to that of 450 B.C., at A.D. 1000. The corresponding high-level beach can be recognised in the Lahontan basin, and we find that between these two maxima, sub-aerial deposits extended below the present level of Lakes Pyramid and Winnemucca, pointing to a rainfall below the present; the tree curve dates this as A.D. 650 to 850. Finally, a tree killed by the rising salt water of Lake Mono was 500 years old, showing that the rainfall has been slight since A.D. 1400.

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[1] "Quaternary Climates: Geologic History of Lake Lahontan," by J. Claude Jones; "On the Pleistocene History of the Great Basin," by Ernst Antevs, "The Big Tree as a Climatic Measure," by Ernst Antevs, "Tree Growth and Climatic Interpretations," by Ellsworth Huntington. (Publication No. 352.) Pp v+212+10 plates. (Washington: Carnegie Institution, 1925.)

This comparison of two different sets of data gives a rainfall curve which can apparently be accepted with a good deal of confidence. Huntington, however, adopts a different interpretation: he considers that the long dry period preceding the formation of Lakes Pyramid and Winnemucca is the American representative of his Caspian drought of A.D. 650, and to make the dates fit he arbitrarily reduces Jones's determination of the age of these lakes by one-half. He states that "that is the earliest time when there is any evidence of so dry a period within historic times"; but it happens that there is abundant evidence of a prolonged dry period in Europe ending in 850 B.C., agreeing remarkably well with the combined evidence of the lakes and the trees in America.

News and Views.

WE record with deep regret the death on February 8, at sixty-four years of age, of Dr. W. Bateson, F.R.S., Director of the John Innes Horticultural Institution and past president of the British Association; also of Dr. W. E. Hoyle, formerly Director of the National Museum of Wales, on February 7, at seventy-one years of age.

UNDOUBTEDLY the best-planned museum in the British Isles, and one of the best in the world, is the National Museum of Wales. It is therefore regrettable that the completion of the Museum should so long have been delayed by unforeseen financial difficulties. The Council in its eighteenth annual report announces that further grants from H.M. Treasury for building purposes are contingent on the collection of considerable sums from other sources, and it therefore again appeals for the sum of 55,000*l.*, so that, with proportionate aid from the Treasury, at least the existing portion of the building may be completed and thrown open to the public. The donations to this end during the past year have been singularly few, but include 1500*l.* from Sir Wm. Reardon Smith and Lady Smith, as an instalment of their latest promised contribution of 5000*l.* Are there not among zoologists and museum men, several who would gladly give a trifle in recognition of the splendid work accomplished for this Museum by their old friend and colleague, the late Dr. W. Evans Hoyle? Now, under a Director energetic in another branch, archæology, especially in the field, bulks largely in this report. The excavation of the suburb of the Roman fort Y Gaer, near Brecon, also the investigation of Offa's Dyke and Watt's Dyke, are of particular interest. Among important additions is the botanical collection made by the late J. A. Wheldon of Liverpool, particularly rich in mosses, liver-worts, and lichens. But perhaps the most interesting paragraph of this report is that which tells how a summer school for museum curators was held at the National Museum last June and attended by sixteen representatives of twelve Welsh museums. The two days' course proved so successful that it is likely to be followed by another during the present year.

THE economic organisation and conditions of primitive peoples have been somewhat neglected by economists. Articles on the subject, however, have been included in the January supplement of the *Economic Journal*—the first of a series to be devoted to economic history. Prof. Muntz, of New York University, treating of the early development of economic concepts, selects Africa for his examples. There, he says, the vast majority of the native tribes were well acquainted with trade in some manner or another before contact with Caucasian peoples. Some tribes specialised in the manufacture of cotton goods, others in iron work; some were primarily agricultural, others pastoral, while in the forest many groups were in the hunting stage. The Bushmen and Hottentots had little or no notion of commercial exchange, though the latter had flocks and herds, could forge iron, and manufacture pottery. The most primitive form of peaceful exchange was that by means of reciprocal gifts, which were customary among the Bihénos and other tribes. Dumb barter or silent trade was carried on in many parts, as, for example, by the pigmy race of the Batuas or Akkas. Certain tribes, however, seem to have passed beyond the crude stage of barter. Salt formed a medium of exchange among the Latoukas, on the west coast and even in the interior. Indeed, throughout Africa the expression "a salt-eater" designated a rich man. Cowrie shells were employed for smaller transactions.

IN another article in the *Economic Journal* for January, Mr. Raymond Firth describes the primitive industries of the Maori. The unit was the village group, consisting usually of persons united by ties of kinship. Only the tattooer, the carver, or the tohunga (priestly adept) would be specialists, though some of the men might devote particular though not exclusive attention to one task. Barter with other tribes was always a matter of ceremonial exchange of gifts; haggling or bargaining was not tika (i.e. etiquette). An adequate return for a gift, however, was expected, and if it was not given would be a subject of comment. So, after all, it would appear that "homo œconomicus" was latent if not active. Industry was largely organised on a communal basis, and the products of fishing or the chase were added to the communal larder. Likewise agriculture, house building, or the felling of trees, was communal, though the right to private property was recognised where things such as fish-hooks, tools, pigeon troughs, etc., were made by an individual.

During November and December, Mr. E. H. Embree, Director of the Division of Studies of the Rockefeller Foundation, and Dr. Clark Wissler, head of the Department of Anthropology in the American Museum of Natural History, visited the eastern universities of Australia inquiring into plans for the energetic prosecution of anthropological work on the mainland and in the Pacific islands under Commonwealth administration. Last year the Foundation expressed itself as warmly interested in this work and appreciative of its urgency, and, although the visitors have not been in a position to make specific promises of financial support, their visit has greatly increased the probability of immediate and hearty co-operation between Australia and the United States in developing a campaign of work. It is understood that Mr. Embree and Dr. Wissler incline to the view, which is also fairly general in Australia, that anthropological work on the mainland should remain in the hands of individual workers or groups in the several States, but that the work in the islands should be organised from the new School of Anthropology in the University of Sydney, under the advice of a representative Australian board or council. It is expected that Prof. A. Radcliffe-Brown, who will be the first occupant of the new chair, will visit Washington on his way to Australia to confer with the officers of the Foundation.

Prof. A. Radcliffe-Brown, who has now relinquished his appointment of professor of anthropology in the University of Cape Town on his appointment to the newly instituted chair of anthropology in the University of Sydney, will arrive in England in the course of February. Before proceeding to Australia he will deliver a course of three public lectures at the London School of Economics, Houghton Street, Aldwych, W.C.2, on March 10, 12, and 15, at 3 P.M. The subject of the lectures will be "The Study of Backward Peoples: its Method and Practical Value." The series promises to be of considerable interest, as the subject is one on which Prof. Radcliffe-Brown is known to hold strong and original views. Admission to the lectures is free and without ticket.

At a meeting of the Linnean Society on January 7, Prof. F. Wood-Jones gave a brief account of the fauna and flora reserve on Kangaroo Island, South Australia. This reserve—known as Flinders Chase—comprises some 200 square miles at the western end of the island. It was set aside as a sanctuary by the Government of South Australia by Act of Parliament in 1919. The administration of the reserve is carried out by a small Board which has to raise funds for the Chase, the Government granting a pound for pound subsidy. It is intended that the reserve shall function not only as a sanctuary, but also as a depot for the legitimate supply of scientific material to workers in Australia and other lands, and for the furnishing of living animals to zoological gardens, specimens to museums, and pelts to the fur market. In this way the Board is confident that ample revenue can be raised for much needed work upon the Chase, and, granted a continuance of public goodwill and proper political support, it may be safely predicted that Flinders Chase will rank among the important sanctuaries of the world, and be a cherished possession of South Australia. Considerable progress has already been made in the direction of introducing on the Chase those species which are in most immediate danger of extermination in continental Australia, and this policy will be steadily continued so far as opportunity and funds permit. At the conclusion of the meeting, a resolution was unanimously adopted expressing appreciation of the work which is being done for the preservation of this portion of the South Australian fauna and flora.

Dr. F. Dixey gives an account of the preliminary results of his survey of the country to the north-west of Lake Nyasa in the *Nyasaland Times* of December 15, 1925. Attention was directed to this area by the discovery of fossil Dinosaur bones by Mr. Holt in a sterile wilderness which has remained little known as it is practically uninhabited. This country consists of ridges of the old crystalline rocks, which form the foundation of all this region, with sedimentary beds in the intervening valleys. Dr. Dixey has obtained from these beds a large collection of fossil Dinosaurs from a tract of country 80 miles in length. The beds extend across the Songwe River into Tanganyika Territory. They rest unconformably on the coal-bearing Karroo Beds of Mt. Waller, in which Dr. Dixey has discovered remains of large reptiles, which he describes as millions of years older than the Dinosaur beds. The Dinosaur beds pass eastward under the deposits of Lake Nyasa, which contain fossil shells similar to those still living in the lake. The lake beds occur in successive terraces, some of them hundreds of feet above the level of the lake. Their deposition was followed by volcanic eruptions, of which the line of hot springs that runs throughout Nyasaland represents the final stage. Dr. Dixey reports that this part of the floor of the Rift Valley has been lowered by faults in several stages, each accompanied by an increased tilt toward the north-east. Lake Nyasa originally occupied a small area near Florence Bay, and has increased to its present size by the continued subsidence of the floor of the Rift Valley. The discovery of these fossils represents a valuable contribution to the geology of Africa, for when determined they will give two well-established Mesozoic horizons in Nyasaland.

MR. T. A. JOYCE, Deputy-Keeper of the Department of Ceramics and Ethnography of the British Museum, sailed on February 6 for British Honduras, where he proposes to spend a period of four months in investigating the relics of ancient Maya civilisation. Mr. Joyce's work will be in continuation of the pioneer investigations of Lady Richmond Brown, Mr. F. A. Mitchell-Hedges and Dr. T. W. Gann, who have already spent two seasons on these sites. As the ruins are covered with forest growth, the work of these expeditions has been confined mainly to clearing away the jungle Evidence was, however, obtained of the existence of some remarkable buildings and of at least one structure of a type not known elsewhere in Central America. The masonry of the earlier work was of a higher character than the later This is fully in accord with what is known of the development of Maya culture in other parts of Central America. Nothing is at present known of the origin of these buildings, but the absence of defences would suggest that they were used for ceremonial purposes Mr. Joyce's special knowledge of American archæology should enable him to throw fresh light on the problems of Maya culture as a result of this expedition

EXCAVATIONS in Mesopotamia during the present season are proving highly successful, and the results of the expeditions now in the field, especially the Weld-Blundell Expedition, are likely to produce some remarkable results. At Kish, where the Weld-Blundell Expedition is at work, a number of complete early Sumerian skeletons have been obtained. These will provide valuable material for the elucidation of the physical characters of the early Sumerians and the obscure problem of their ethnological affinities, especially if this material should prove really comparable with the dozen or more skeletons of the Indo-Sumerian period, of which the discovery at Mohenjo-Daro in Sind is announced by the Indian Archæological Department Equally important is the announcement of the discovery of a complete series of perfect specimens of the early painted polychrome and monochrome Sumerian pottery with geometrical design. This is the first discovery of perfect specimens of this ware in any quantity, and places beyond dispute its connexion with the thin pottery of the first Susan period. The pictographic script discovered with the painted ware is the earliest yet known, dating from a period anterior to 3500 B C as a minimum

THE Frankfurt correspondent of the *Times* describes, in the issue for February 3, the position and prospects of the German chemical industry, and some of the efforts it is making to regain the supremacy it enjoyed before the War. Since the conclusion of peace, that industry has encountered a sea of troubles. Foreign countries have developed powerful industries of their own, and strong protective tariffs have been erected against German chemical products both in Europe and the United States Compared with the year 1913, external sales of German dyestuffs have decreased by 50 per cent. and of German fertilisers by more than 95 per cent. The United States now produces 90 per cent. of its requirements in dyestuffs, and Italy, which had practically no dye-making industry in 1913, about 60 per cent. Manufacturing profits in Germany have practically disappeared, loss of territory and raw materials, inflation and scarcity of capital, have combined to retard progress and expansion

IN spite of all this, however, Germany still leads, and is making stupendous efforts to recover her former position of undisputed supremacy in the chemical industry. Belief in the value of scientific research is as potent as ever. The *Interessengemeinschaft* (I G), which formerly dominated the production of dyestuffs in most countries, has nearly doubled its capital, and extended its influence in many ways. It has taken over control of the big nitrogen factories and is energetically developing foreign sales (German farmers now pay less for their fertilisers than in 1913), its technical efficiency, economic cohesion, and other factors make it the most powerful chemical organisation in the world. As in the past, this combination is pursuing an intensely nationalistic and aggressive chemical policy to secure the most effective working of foreign markets, its work is subdivided among groups, each of which is allotted a definite geographical sphere of influence. The South American markets have been recaptured, whilst those in Russia and south-eastern Europe have been nearly secured. Recent attempts to win over the Norwegian manufacturers have so far been unsuccessful, and the overtures to dyestuff producers in Great Britain and Japan are still proceeding.

THE eleventh annual report of the Committee for the Investigation of Atmospheric Pollution, for the year ending March 31, 1925, has recently been issued by the Meteorological Office, Air Ministry (M O. 280 · H M Stationery Office, 5*s* 6*d*. net) The results obtained for the year show that there are large areas of Great Britain which are not represented, but the Midland area, which suffers most from smoke pollution, is taking a very active interest in the investigation. The deposit of impurity is registered at forty-eight stations, the results are given for each month, also the summer total, winter total, and total for the year A comparison is made between the general average and the average at the same stations for the previous five years. The amount of rainfall is also given; the total was generally more than the average, while the deposit of tar was lower A series of maps shows the position of the gauges at the different stations, which in many cases offers considerable explanation of the results The automatic recorder for suspended impurity shows some very interesting results. For Blackburn, Stoke-on-Trent, and Westminster, curves are given showing the impurities for week days, Saturdays, and Sundays; the industrial and domestic smoke each has its say The smoke from chimneys is largely affected by the wind velocity and direction. Some results are also given of the observations made with the dust counter During the period of widespread fog in London between December 9 and 12, 1924, interesting observations were made in comparison with Cheam, 11 miles south-west of London; there was roughly fifty times as much impurity by weight in the London fog, while there was a much larger amount of water at Cheam. Often at Cheam the limit of visibility was less than in London

AMONG the anniversaries of scientific interest which occur this year is that of the bicentenary of the birth of John Anderson, for forty years professor of natural philosophy at Glasgow. The contemporary of Watt and Black, Anderson was the first university professor in Great Britain to step aside from the beaten track to give regular courses of scientific lectures to men engaged in practical pursuits Four days a week he lectured on physics illustrated by the aid of mathematics, but on Tuesdays and Thursdays the facts that were taken for granted in the other lectures were ascertained "by a direct appeal to the senses, or by stating the testimony of unexceptional authors, whilst the knowledge of these facts was shown to be of great advantage for the improvement of human nature and the progress of the useful and elegant arts" These ideas are set forth in his "Institutes of Physics," published in 1786. Ten years after the publication of this work, Anderson died leaving about 1000*l.* to be applied to the foundation of a university to bear his name. Though the sum was certainly too small to put his whole scheme into practice, a start was made; success was achieved from the first, and from the institution so founded sprang the mechanics institutions of the past and the technical colleges of to-day. Anderson's Institution, Anderson's University, or Anderson's College as it was known in the old days, is now the Royal Technical College of Glasgow, one of the most flourishing institutions of its kind. Anderson was born in 1726, but the exact day does not appear to be known.

AMONG the pioneers of Italian geology a prominent place must be given to Scipione Breislak, the centenary of whose death at Milan occurs on February 15. Born in Rome of Swedish parents, Breislak distinguished himself as a professor of physics and mathematics at Ragusa, and at a time when geology was in its infancy studied the rocks of the Papal States He was also employed by the King of Naples as an inspector of mines During the political upheaval due to the Napoleonic wars, he spent some years in Paris, but afterwards had an official appointment at a powder factory near Milan. His text-book "Introduction to Geology," which was published in 1811, contained an able criticism of the Neptunian dogmas, and did much to eradicate their teaching from the universities and colleges. Breislak was one of those who adopted Desmarest's views on the volcanic origin of basalt.

THE *Lancashire* (later *Lancashire and Cheshire*) *Naturalist* was founded by Mr. W. H. Western, of Darwen, in 1907, and he printed and published it for the common good until 1919. It was then taken over by a committee, and when three years later the committee found itself unable to continue, Mr Western resumed responsibility At the end of last year he found that he did not get the necessary support and was compelled to give it up—a decision which every one interested in the progress of natural knowledge will regret, for the paper has done splendid work in encouraging the examination of the local fauna. Fortunately, however, Mr. A. A Dallman (17 Mount Road, Higher Tranmere, Birkenhead) has come forward with a scheme for re-establishing the journal as the *North-Western Naturalist.* We hope he will receive the support he deserves. The active botanists and zoologists of the district will provide plenty of good material, and Mr. Dallman is anxious to hear from any one who is interested in the scheme, and especially from prospective subscribers and those who would be willing to help the paper over its first year or two by means of a guarantee.

THE arrangements for the Optical Convention, the meetings and exhibition of which will take place in the Imperial College of Science and Technology, South Kensington, during the week April 12-17, are now well advanced. An important part of the work of the Convention will be the exhibition, which is being arranged to be fully representative of British optical manufacture in all its branches Apart, however, from the commercial section of the exhibition, it is intended to have an Experimental and Research Section, to which it is hoped private individuals and research and teaching institutions will contribute. Those who have exhibits suitable for inclusion in this section are invited to communicate, not later than February 27, with the Secretary of the Optical Convention, 1926, 1 Lowther Gardens, Exhibition Road, London, S.W.7. A brief description of any exhibit accepted will be required, for inclusion in the catalogue. Those who wish to offer exhibits of historic interest should communicate with Mr. D. Baxandall, at the Science Museum, South Kensington, S.W.7, who is arranging the historical section.

THE Minister of Health, in conjunction with the Medical Research Council, has appointed a Committee to inquire and report from time to time, (1) on matters relating to the preparation, testing, and standardisation of vaccine lymph, (2) on practical methods of diminishing risks which may result from vaccination; (3) on the methods of vaccination which are most appropriate to give protection against risk of smallpox infection in epidemic and non-epidemic periods; and to co-ordinate the work on these questions in Great Britain and abroad. The Committee consists of: Sir Humphry Rolleston, Bart. (chairman), Dr F. R Blaxall, Dr G. F. Buchan, Dr. A E. Cope, Dr. Mervyn H. Gordon, Prof. J. C G. Ledingham, and Mr. J. R. Perdrau. The secretary of the Committee is Dr. J. R. Hutchinson, a medical officer of the Ministry of Health, Whitehall, S.W.1, to whom all communications should be addressed.

IN recent years the activities of the Optical Society have expanded in many directions in the field of optics, and the report of the Council of the Society presented at the annual general meeting of members on February 11 gives evidence of further development. During the past year the Council undertook the preliminary arrangements which resulted in the appointment of a representative committee to organise an optical convention in 1926. The formation of an Ophthalmological Section of the Society is now contemplated, and preliminary meetings devoted to the consideration of papers of an ophthalmological character have been arranged and have provided evidence of the increasing amount of scientific work that is being done in connexion with ophthalmological optics. In order to facilitate and extend the use of the decimal bibliographical classification of the Institut International de Bibliographie, a manual dealing with the application of that classification to optics, light and cognate subjects has been prepared and will shortly be published by the Society. The revenue accruing from the increased sales of the Society's Transactions has placed the finances of the Society in such a satisfactory position that the subscription payable by members has been substantially reduced and the entrance fee suspended

THE *Quarterly Review* for January (No. 487) contains an instructive article by Prof. J. Arthur Thomson entitled "Biology and Social Hygiene," the general moral of which is "that social organisation is not necessarily a good thing in itself. It requires to be scrutinised not only in terms of wealth and health, both so conspicuous in the bee-hive, but in terms of the higher values—the good, the beautiful, and the true, with their outcome in the evolution of man's personality." Prof. Thomson would recommend to the Ministry of Health the discovery and utilisation of outstandingly healthy men and women as missionaries of health, the revival in every town and village of a Beautifying Society, a more conscientious criticism of what we buy, more selection for health, and lastly, an order of merit for outstanding health! He pleads for more biology in education, so that pupils leaving school would be interested in the world without, both animate and inanimate. Lastly, on eugenics, child-breeding and rearing, some very sane opinions and conclusions are expressed on the controversial subject of birth control.

RECENT winter storms which have wrought so much destruction in the North Atlantic, including the loss of the *Antinoe*, the crew being rescued by the *President Roosevelt* on January 27 after four days struggle with the elements, and the *Laristan*, which sank on the same day after the rescue of six of her crew by the *Bremen*, are the subject of an article in the *Times* of February 6 by Sir Napier Shaw. The stormy period is likened to the winter of 1898–9, which was made the subject of a special inquiry by the Meteorological Office. Just twenty-seven years ago, considerable anxiety was caused by the delayed arrival of vessels overdue, including the Cunard Liner *Pavonia* and the Hamburg-Amerika ship *Bulgaria*. For this special inquiry, information had to be extracted from the logs of ships. To-day, observations transmitted by wireless are sufficient to give necessary details. The conditions are similar; the main feature is the belt of vigorous air current across the Atlantic nearly along the shipping lanes from west to east and on to the Scandinavian coast. The westerly winds are fed by a current from the cold north-west over Labrador and eastern Canada, and a feeder from Bermuda or from the Gulf of Mexico. One feeder is cold and dry, the other warm and moist; these throw the air of the North Atlantic into convulsions. A feature in both stormy periods referred to is the intense cold experienced in America on one side of the Atlantic, while on the other side, in Great Britain, the weather was unseasonably mild Sir Napier Shaw hints at certain calculations common to the two stormy periods, and concludes that we must expect still to find the Atlantic the scene of wrecks, unless we can develop still further our capacity to build invulnerable ships.

IN 1922 the Council of the British Psychological Society, at the request of the Educational Section of the Society, established a Committee for Research in Education. This Committee has now published a brief summary of its work in the past three and a half years. It has attempted to secure better understanding and closer co-operation between educationists and the research workers in the departments of psychology and education in our universities, and possibly its most important activities have been putting investigators into touch with those competent to give advice on particular research problems and advising and assisting heads of schools with regard to the use of mental tests. Periodic inquiries have been made as to researches bearing on education that are in progress, and summaries of the information so obtained are given in the *British Journal of Psychology*, Vol. 14, Part 4, and Vol. 15, Part 4. The place of psychology in the curriculum of training colleges formed the subject of another inquiry, and a summary of the detailed information received from sixty-three colleges was published in Vol. 2, No. 2, of the *Forum of Education*. Another side of the work of the Society, likely to grow both in amount and in importance, is international. In co-operation with the University of Toronto it is compiling a bibliography of mental tests published in England and, to assist the University of Iowa in an investigation of "arithmetical norms," it has secured "completed tests" from a number of schools in England.

THE French Association for the Advancement of Science will celebrate its jubilee this year at the annual meeting to be held at Lyons. An international Exhibition for the Advancement of Science, to include all branches of science and its applications, is being organised for July 24-August 1. M. Pilon, 23 rue Casimir Perier, Paris, has been appointed Commissaire Général of the Exhibition.

IT is announced that the first Federal Conference of Turcoman Educators will be held at Baku on February 20. The subjects will be the language, history, ethnography, and literature of the Tartar and Turcoman peoples, as well as Tartar and Turcoman education

Among those who have signified their intention to be present are Profs Oldenburg, Barthold, Marr and Pavlovitch. In this connexion it is interesting to note that a proposal has been mooted and favourably received at a meeting held on December 14 last, for the substitution of Latin characters in place of Arabic as the basis of a new Turcoman alphabet A committee of the Scientific Orientalists' Association has been formed to take steps to introduce the new alphabet.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned —A whole-time analytical chemist under the County Council of Dumfriesshire, as public analyst under the Sale of Food and Drugs Acts—The County Clerk, County Buildings, Dumfries (February 19). A Live Stock Officer under the Ministry of Agriculture and Fisheries—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W 1 (February 22) A laboratory assistant at the Building Research Station of the Department of Scientific and Industrial Research—The Director of Building Research, Building Research Station, Garston, near Watford (February 22). An assistant in the Technical Records Section of the Admiralty—The Secretary (C.E.), Admiralty, Whitehall, S.W.1 (February 22). An assistant curator in the Department of Antiquities and Anthropology of the Bristol Museum and Art Gallery—The Director (March 6). A lecturer in applied chemistry in the Manchester Municipal College of Technology—The Registrar (March 12). A professor of mathematics in the University College of North Wales, Bangor—The Registrar (March 20). An assistant (museums) at the Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S W.1 (March 31) A calculator for the Royal Airship Works, Cardington, Bedford—The Director of Airship Development, Royal Airship Works, Cardington, Bedford. A junior assistant under the directorate of explosives research of the Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E 18

Our Astronomical Column.

COMETS —Dr. Baade detected Tuttle's periodic comet on January 12, 19^h U T in R.A. $22^h 27^m 52^s$, N Decl 40° 18′; the magnitude being 15·5. The daily motion is $+3\frac{1}{4}^m$, south 10′. The time of perihelion passage is deduced to be April 28·73 U.T., which is 1·08 days later than the ephemeris of Idelson and Musselius, 3·33 days earlier than that of Stobbe The period is 13·54 years, the last passage having been on October 28·543, 1912. The comet was seen at the returns of 1790, 1858, 1871, 1885, 1899, 1912 Its detection at the 1912 apparition was accidental, as no one had calculated the perturbations by Jupiter, which were large, so that it came two months before it was expected

It will probably be visible with moderate instruments on March 4-15, when the moon will be out of the way. In April it is too near the sun for convenient observation.

Mr. H E. Wood has sent a series of observations of Ensor's comet made by him at Johannesburg between December 14 and 21; from these Mr. G Merton and Dr. A. C. D. Crommelin have revised the orbit as follows:

T	1926 Feb 11·974 U.T
ω	354° 55′ 43″
Ω	282 26 56
i	123 1 5
log q	9·50852

EPHEMERIS FOR 6^h U.T.

	R A	Decl
Feb. 16.	20^h 56 0	10° 57′ S
,, 24.	20 52·0	3 47 N
Mar. 4.	21 2·8	21 4 N

The comet should be looked for in the east about dawn.

SOLAR RESEARCH AT MOUNT WILSON.—Since the publication in this journal (Supp, January 19, 1924) of a summary of the results obtained by Dr Hale and his colleagues from their comprehensive investigations in solar physics during the last seventeen years, a more detailed account of their observations and conclusions has been awaited with great interest. This is presented in the *Astrophysical Journal* for November 1925 (vol. 62, p. 270), and bears witness to the untiring skill of the Mount Wilson observers in their examination of 2200 spot groups for polarity and field-strength It would be out of place to attempt to give a summary of this paper, when it has been already more ably and completely given by Dr Hale himself in the supplement mentioned, to which reference should be made for further information It may be mentioned, however, that more details are given, both of the observations and of the results obtained, than in the previous account, while a revised scheme of classification into unipolar, bipolar, and complex groups, is fully described with various subdivisions

The nature of the hydrogen vortices, as shown by direction of whirl, is discussed in another paper by Dr. Hale (*Proc. Nat Acad. of Science*, November 1925). According to the electromagnetic theory of Stormer, these vortices are composed of charged particles constrained to move along the lines of force of the magnetic fields due to the spots beneath. The observations at Mount Wilson, however, show that the sign of the charge producing sunspot fields is invariable, a change of polarity being due to reversal of the direction of whirl. Change of polarity in the sunspot should produce a reversal of the direction of motion in the hydrogen vortices, according to the electromagnetic theory, but the observations do not confirm this, and Dr. Hale is led to the conclusion that the hydrogen vortices are purely hydrodynamical phenomena corresponding to terrestrial cyclones

ANOTHER ALGOL VARIABLE —In 1922, Miss Woods of Harvard College Observatory found that the star BD − 7° 5271 was faint on 6 plates out of 85 examined, and concluded that it was a variable, probably of the Algol type. Nothing more was published concerning the star for three years, Mr J. Witkowski of Cracow Observatory now publishes a series of observations ranging from July 30 to Oct. 30, 1925 (*Acta Astronomica*, Dec. 30, 1925). He confirms the type as being that of Algol The period is 2·1387 days, the light-range from 9·8 to 11·1 mag., and the duration of eclipse 6 hours The minimum is fairly sharp, and the light-curve symmetrical about it.

The position for 1925 0 is R.A. $20^h 18^m 12^s$, S Decl. 7° 35′·4, spectral type A 2.

The observations were made with a comet-seeker of $5\frac{1}{4}$ in aperture The star is thus within reach of observers with moderate equipment.

Research Items.

A Wood-carving from Easter Island.—In the *Museum Journal* (Philadelphia) for June last, which has recently been issued, Mr. H. U. Hall figures an example of that rare type of the so-called household gods of Easter Island which shows a combination of features of both human and animal forms. Five figures only of this type are mentioned in Dr. Brigham's survey of Polynesian material in museums, and three additional are known to have been at one time in the hands of private owners. The one here described by Mr. Hall is in the University Museum, Philadelphia. It represents a lizard-man, but it differs in detail from a similar lizard man formerly in the possession of Mr. J. Edge-Partington with which it is compared. The lower portion of the image ends in a rounded handle. The arms are brought together in the position of a suppliant. Other examples of these images are pierced with a hole to enable them to be carried strung on the person in procession, but this example, being some two feet long, was obviously carried by the handle, which shows signs of much use. Mr. Hall doubts whether it really represents a man-lizard. It may be an unconsciously anthropomorphised lizard. The lizard in Polynesia has a considerable prominence in magic and religion. Its appearance in Easter Island may be a memory of this prominence, or as an egg-producing animal it may have been regarded as a peculiarly effective mediator with the gods. This conception may have been helped by the prominent part played by the first egg of the season of a certain type of sea-fowl in the bird-man cult.

The Prehistoric Cultural Provinces of the Iberian Peninsula.—MM. Bosch-Gimpera and L. Pericot publish in *L'Anthropologie*, t. 35, Pts. 5-6, an important classification of the archæological remains of Spain and Portugal in the neolithic and æneolithic periods, by which they show that the Iberian Peninsula at these times can be divided up into a number of cultural provinces which persist into the Bronze Age, when they disappear, and do not appear again until the Iron Age. After briefly surveying the cultures of the palæolithic, epipalæolithic, and protoneolithic periods, which are derivative from the Franco-Cantabrian and the Capsian of the palæolithic, with an indigenous, but fully differentiated, culture on the Atlantic coast to be attributed to the influence of environmental changes, and an intrusive culture at Almeria, they distinguish four cultural provinces in the neolithic period: a western or Portuguese culture; a Central culture—this being a culture of special importance, of which the main characteristic is the highly decorated bell-beaker; the Almerian culture, and the Pyrenean culture. Each of these shows a continuous development with, however, certain advances and interactions except in the case of the Pyrenean culture, which apparently disappears for a time, possibly owing to failure to develop, but reappears in the æneolithic stage. At this period, indeed, it becomes sufficiently strong to force the retreat of the northernmost extension of the Almerian culture which had spread along the east coast of Spain at the beginning of the æneolithic period. The western culture is characterised in particular by the megalithic type of burial, and while in the earlier phases it was confined to Portugal, and in particular the north and centre, at a later stage, in the æneolithic period, it extended eastward and especially into Estramadura, Salamanca, and Huelva.

The Fishery of the Greenlanders.—In No. 7, *Meddelelser fra Kommissionen for Havundersøgelser Ser. Fiskeri*, Bind 7, Prof. Ad. S. Jensen gives a most interesting and well-illustrated account of the fisheries of Greenland. Dr. J. Schmidt in the preface points out that the author was leader of the fishery investigation expedition sent out by the Danish Government with the brig *Tjalfe* in 1908–9, and that many of the important observations regarding the Greenland Halibut made during those expeditions have been turned to practical use, proving a source of real profit to the Greenlanders. Several of those species which play a great part in the international fishery carried on in adjacent waters are almost, or entirely lacking in Greenland, the haddock for example, and the plaice and other flatfishes, with the exception of the halibut and Greenland Halibut. Prof. Jensen is inclined to believe that the stock of cod in Greenland is mainly recruited from elsewhere by immigration. He thus directs attention to an important problem which is also of interest in connexion with the Iceland investigations.

Hydrography of the English Channel.—In *Rapport Atlantique* 1924 (Conseil Permanent International pour l'Exploration de la Mer) Mr. H. W. Harvey, Hydrographer at the Marine Biological Laboratory, Plymouth, gives a useful summary of the results, and interpretations based upon them, which have been obtained by various workers who have studied the hydrography of the English Channel. An account of the extent of our present knowledge of the features of the water movements, and the variation of temperature and chemical composition of the sea water, is followed by a discussion of their biological significance. Two observations regarding the herring are of interest. A result of water movement in the English Channel is that herring spawned in the eastern end of the Channel are likely to be carried into the North Sea. A comparison between the mean weight of herring per landing by steam-drifters at Plymouth during the herring season—December and January—since 1921, and the temperature at a depth of 5 metres, shows that for four consecutive seasons the mean weight per landing has reached its seasonal maximum when the temperature has been between 10° C. and 11° C.

Corals and Zooxanthellæ.—Dr. H. Boschma, working on living material collected at the Bermuda Biological Station, records observations on the part played by unicellular algæ (zooxanthellæ) in the nutrition of corals (*Proc. Amer. Academy Arts and Sci.*, vol. 60, No. 9, Nov. 1925). Most of his experiments were carried out with Isophyllia, which has large polyps. The statements in the literature that the cœlenteron seldom contains food are based chiefly on the examination of preserved material, the polyps of which have discharged the contents of the cœlenteron owing to the strong contraction which takes place on preservation. Under normal conditions, the food of the polyps consists chiefly of the algæ which are living in its endoderm cells—and in freshly collected specimens algæ are always present in the mesenterial filaments, small planktonic organisms are also captured and digested, but under normal conditions these are too scanty to serve as the sole nutriment of the polyps. When the digestive organs (the mesenterial filaments) can obtain sufficient food from other sources—as in examples fed in the laboratory with mussel—they do not ingest zooxanthellæ. The algæ which were present in the filaments are completely digested, so that after abundant feeding on mussel, the mesenterial filaments may become totally devoid of zooxanthellæ. The symbiotic algæ are ingested only when other food is scarce, and to this extent the polyps are parasitic on the algæ. In other Bermudian Anthozoa the zooxanthellæ form a large part of the food supply of the polyps. In a further paper (*Biol. Bull.*, Dec. 1925) the author states that in Astrangia also the zooxanthellæ furnish part of the normal food of the polyps, and that polyps which have no zooxanthellæ can be easily infected by feeding them with crab meat mixed with parts of the tissues of strongly infected polyps.

THE FLORA OF JUAN FERNANDEZ AND HAWAII.—Prof. Carl Skottsberg, Director of the Botanical Garden at Gothenburg, Sweden, was Bishop Museum Fellow in Yale University for 1922–23; and as a result there is published as *Bulletin 16 of the Bishop Museum*, Honolulu, a very interesting phytogeographical discussion of the flora of the islands of Juan Fernandez and Hawaii. Both are groups of volcanic islands, very remote from each other, but with common features in their flora. Prof. Skottsberg considers that they are young islands of which the flora contains many isolated types, the result of isolation of considerable age, and of geographic changes. The high endemism, he concludes, is scarcely likely to be due to the extermination in all other countries of identical or closely allied species. There is evidence in favour of a continental origin of the Juan Fernandez flora; that it existed before the present islands were formed, and took possession of them during the submergence of its old home. Part of this flora he derives from the Antarctic continent, but by way of South America rather than by a direct land bridge. Hawaii also contains old Pacific and Antarctic types, but the road from Polynesia to Hawaii is more difficult to trace. However, the author is confident that the history of the Hawaiian flora is in main outline similar to that of Juan Fernandez. Another general conclusion is that the disappearance of the Tertiary Antarctic flora during the Ice Age is of fundamental importance and has been greatly underrated by plant-geographers. "No catastrophe of such dimensions and of such consequences has ever befallen the Tertiary flora of the Northern Hemisphere." The Bishop Museum Yale Fellow for 1921–22, Prof. F. L. Stevens, of Illinois, gives a full list of the fungi known to exist in the Hawaiian islands as *Bulletin No. 19 of the Bishop Museum*. Most of these are from collections made by himself in 1921, but all other available collections and lists are included; rusts, smuts and parasitic fungi have been more thoroughly collected, higher fungi and fleshy Agarics only taken incidentally.

TCHEVKINITE AND AFFINITIES OF TRILOBITES.—A series of eight papers in Russian, French, German or English, and an appendix containing abstracts of recent non-Russian scientific literature appears in the *Bulletin of the Russian Academy of Sciences*, Series 6, Nos. 12-18, 1924. Three papers, in Russian, by Boldyrev, Kaufman and Kryzanovskii describe the rare mineral tchevkinite, which is a titanosilicate of cerium, lanthanum and other metals, from the Ilmen Mountains. The mineral was originally regarded as an amorphous alteration product; some Russian crystals have now been thoroughly investigated and are found to be monoclinic, confirming the doubtful suggestion by Prof. Lacroix from Madagascan specimens. In a discussion, in English, of the relations of the trilobites by Fedotov, many of Walcot's genera are rejected as based on inadequate material, and the author concludes that the trilobites, though closely akin to the Crustacea, are an independent group ancestral to the arachnids. Nasonov describes the general distribution of the *Turbellaria rhabdocoelida* in European Russia.

POST-EOCENE MOLLUSCA OF NORTH-WESTERN INDIA.—The late Dr. Vredenburg, to whose four excellent memoirs on the Indian Tertiary gastropoda we directed attention in these pages (NATURE, May 6, 1922, p. 594, and August 25, 1923, p. 294), had at the time of his lamented death in March 1923 just completed the proofs of the memoir now before us. This "Description of Mollusca from the Post-Eocene Tertiary Formations of North-Western India" has now been issued by the Geological Survey of India (*Memoirs*, vol. 50, pt. 1). The forms dealt with were obtained from the stratigraphical division distinguished by Blanford as the Nari, Gáj and Mekran. The detailed study of these fossils has revealed the existence of many species already known either from Europe or from the East-Indian archipelago. A widespread temporary oceanic connexion established by the great marine oceanic transgression of the Oligocene, undoubtedly accounts for the mingling of eastern and western forms at this horizon. Some 150 species, a large proportion of which are new, are fully and carefully described in this ample memoir, and many of these are illustrated on 13 plates from photographs taken by the author himself, whose demise is assuredly a great loss to palæontology.

ISOSTASY IN THE SOUTHERN PACIFIC.—In the *Journ. Wash. Acad. Sci.* for December 4, William Bowie gives the results of an isostatic reduction of gravity determinations at five island stations in the Southern Pacific. Assuming a depth of compensation of 96 km., the isostatic anomalies that remain vary from +0·003 dyne to +0·061 dyne, the average being 0·033 dyne against an average free-air anomaly of 0·130 dyne. The theory of isostasy thus reduces the difference between observed and calculated values by 75 per cent. In explanation of the rather high anomalies that still remain, Bowie considers that in part they may be due to errors in the observations, the possible inaccuracy being so high as 0·010 dyne, but that a more important cause of divergence is a probable excess of density in the rocks underlying the islands. In the calculations the rock density is taken as 2·7, which, according to Washington's figures, is undoubtedly too low. By taking the density as 3·0 the average anomaly is reduced by about a half. The evidence is thus in close accord with that of land-data and supports the assumption that the earth's crust under the oceans is in an isostatic condition.

TIDAL FORCES AND CONTINENTAL DRIFT.—At the annual meeting of the Geological Society of America held during last December, F. B. Taylor, who anticipated Wegener in an hypothesis of continental drift, read a paper in which he advocates a remarkable theory of the origin of the moon. He considers that the Tertiary mountain ranges were raised as a result of the horizontal sliding of continental blocks towards the equator; that the evidence strongly points to an external cause for the movement; and that tidal forces are therefore the only causes to which adequate appeal can reasonably be made. Solar tidal forces alone are held responsible for the older mountain ranges. Near the close of the Cretaceous, however, a sudden and strongly-marked increase of crustal movements began, and has continued with diminishing energy down to the present day. There is no way of explaining this world-wide increase, according to Taylor, without assuming a corresponding increase in tidal force, and this assumption involves the acquisition by the earth of a body like our present moon and its permanent retention as a satellite. The implied capture theory of the moon is stated to be sound from the astronomical point of view. With regard to mountain building, Taylor's views are not likely to meet with acceptance. The moon's tidal force is approximately 215 times more powerful than the present solar tidal force, and there is certainly no geological evidence to suggest that the Alpine-Himalyan mountains are the result of forces 216 times as great as those which produced the Armorican, Caledonian, and older mountain systems The recent work of Joly and Holmes, to which Taylor makes no reference, shows that no theory of crustal movements can possibly be complete which ignores the almost incredible forces set up as a result of the liberation of energy from radioactive elements. Here we have an indubitable cause of mobility permitting conditions in which tidal forces can become effective, and involving no such gratuitous assumption as the capture of the moon in Cretaceous times

SUPERFICIAL SOLUTIONS, OR TWO DIMENSIONAL FLUIDS —M A Marcelin, in the *Annales de Physique* for November-December, deals with the thin films formed by certain oils on the surface of water from a new point of view. It has been supposed that the extension of the surface of the oil could go on until a layer of molecules was formed which were in contact with one another at their sides, and that if the amount of oil for a given surface was too small to cover it with such a layer, no change took place in the surface tension. Using, however, two-dimensional floating apparatus, cut out of paraffined mica, and representing pumps with valves and pistons, the author has been able to show that the surface tension is lowered for very much smaller amounts of oil than the above. If the amount of lowering is regarded as the "surface pressure," p, a law holds similar to that of Boyle and Mariotte for gases, $pS = \text{constant}$, where S is the surface This is true up to about twenty-eight times the surface occupied by the oil in a monomolecular layer, with all its molecules in contact with one another, a state which corresponds to that of a saturated vapour. M. Delaplace has found that Gay Lussac's law applies to these superficial solutions between 15° and 27° C., so that $pS = KT$, where K is a constant characteristic of the floating molecule, and probably also depending on the liquid on which it floats

INTERFERENCE BANDS —In the October and November issues of the *Journal de Physique*, M F. Wolfers describes a new system of interference bands he has discovered in the penumbra cast by the edge of an opaque screen when illuminated by a source of considerable dimensions. The best arrangement for observing them is a narrow horizontal slit illuminating a steel ball about 1 cm in diameter, and behind the ball a fine grained photographic plate. Along a horizontal diameter the light, instead of falling off gradually from the edge of the penumbra to that of the umbra according to the ordinary theory of diffraction, is found to show three or four bands the intensity of which is greatest near the edge of umbra. Their positions are independent of the nature, dimensions, and form of the source and screen and of the nature of the surface of the latter, nor does the light from them show any signs of polarisation. Their positions in terms of the wave-length of the light used, and the distances of the screen from the source and photographic plate, lead the author to conclude that they are due to interference of light coming from that part of the source which determines the edge of the umbra with light coming from the edge of the screen where it has been absorbed and emitted in quanta.

PHOTOGRAPHING THE INNER SURFACE OF A RIFLE BARREL.—The difficulties of inspecting and photographing the inner surface of a rifle barrel with a length of about 700 mm. and an internal diameter of about 6 mm have been ingeniously overcome by Mr. Seiji Nakamura, of the Physical Laboratory of the Tokyo Imperial University, by the construction of an instrument called a "solenoscope" (*British Journal of Photography*, 1926, p. 19). The final form of this instrument is a steel tube about 750 mm long and 6 mm external diameter, which has at one end a larger brass tube in which the eyepiece slides, and carries at the other end a microscope objective formed of two simple lenses, achromatism being found unnecessary. The eyepiece is an orthoscopic magnifier of Zeiss of 18 mm. focal length, and at the other end, beyond the objective, is a small 3-volt electric lamp. In order to get the image through so long and narrow a tube, five achromatic cemented doublets of about 68 mm. focal length are placed at a distance apart equal to twice the focal length of each Thus the image formed by the first is reproduced by the third (inverted) and again by the fifth (erect), and so viewed or photographed through the eyepiece. The second and fourth lenses act as condensers to avoid loss of light and are fixed where the two middle images are formed, but slightly removed from these positions to avoid the image of dust, etc, on their surfaces appearing in the final image. The resulting image is an evenly illuminated annulus which represents a short length (or ring) of the barrel. The paper is illustrated and has a photograph of a new barrel and one of a much-used barrel, which clearly demonstrate the efficacy of the instrument.

TRINITRIDE AND CYANATE IONS.—Experiments on the X-ray spectra of trinitrides (hydrazoates) and potassium cyanate made by S. B. Hendricks and L Pauling show that the trinitride and cyanate ions have closely similar configurations. An interesting result of the work, which is described in the issue for December 1925 of the *Journal of the American Chemical Society*, is that the trinitride ion is shown not to have a ring structure but to contain three nitrogen atoms in line (as in Thiele's formula)

RESISTANCE THERMOMETERS AT LOW TEMPERATURES —Some experiments by A G Loomis and J. E. Walters are described in the issue for December 1925 of the *Journal of the American Chemical Society* which were intended to test the applicability of platinum resistance thermometry to -193° Four platinum thermometers of the flat-coil type showed close agreement between observed and calculated resistances at the carbon dioxide point, and the flat coil types could, when properly constructed, be used at low temperatures and calibrated in the same manner as the strain-free types investigated by the Reichsanstalt and the Bureau of Standards

PARTIAL PRESSURES OF WATER VAPOUR AND SULPHURIC ACID —The December issue of the *Journal of the Chemical Society* contains an account of the investigation of the partial pressures of water vapour and sulphuric acid vapour over concentrated solutions of sulphuric acid at high temperatures, by J. S Thomas and W. F Barker. Air was passed through the acid and the saturated air passed to absorbing vessels. The results apply to sulphuric acid of concentrations between 89·25 and 99·23 per cent, and temperatures from 180° to 295°. It was not possible to take account of dissociation . figures are given on the assumption that the acid is not dissociated and another set on the assumption that it is completely dissociated. The results should be useful in connexion with large scale concentration apparatus

The Control of Insect Pests in Agriculture.

THE completion of the Ministry of Agriculture scheme for the appointment of advisory entomologists in each of the fourteen agricultural provinces of England and Wales has recently been fulfilled By means of this organisation, the Phytopathological Branch of the Ministry is now enabled to keep in touch from year to year with most parts of the country with regard to the incidence of insect pests. Each advisory entomologist has his headquarters in a collegiate or university centre in his province, and his field of work lies in the diagnosis of injury due to insect pests on behalf of the farmers and growers of that area, he is further concerned with the dissemination of useful information on such subjects, and in the carrying out of experiments on the practical control of pests of local importance At present the advisors' duties are therefore of a somewhat comprehensive character As time goes on, it is reasonable to hope that as the county councils' staffs develop and extend their spheres of utility, they will be able to take on much of the purely advisory duties. In this way it should eventually be possible to free the advisor in order that he may be able to devote his inquiries more especially to the investigation of particular local problems

The work of the advisors renders them in a position to forward to the Ministry annotated lists, or in some cases more detailed information, respecting the pests that come under their notice There is also a considerable number of voluntary observers located in different parts of England and Wales who assist in a similar manner The information thus garnered is collated and sifted in the Ministry's Pathological Laboratory at Harpenden The present report[1] is to a large extent a summary of the data collected by some sixty-two observers during the years 1922–1924 It is the fifth of its series, but differs from its predecessors in that tabular lists of every recorded species of injurious insect are, very wisely, no longer included Certain innovations in regard to pest control during the years under review are mentioned Perhaps the most notable of these is the application of certain proprietary compounds, collectively known as "carbolineum," as washes for fruit trees These compounds consist of various products obtained in the distillation of coal and are of variable composition There appears to be no question as to the efficiency of certain of the "brands" bearing the name of carbolineum in the destruction of the resting eggs of aphids and apple sucker It is important to know, however, whether such treatment can be carried out over successive years without injury to the trees; also, whether the manufacturing firms are able to give guarantees to the effect that materials which gave good results one year will remain purchasable with their original composition unaltered

Among individual pests the raspberry beetle has always been troublesome to raspberry growers and has also become a menace to loganberry culture Experiments carried out at the Long Ashton station show that it can be largely controlled by spraying the plants with lead arsenate when they are one-third, two-thirds, and fully in bloom Apart from the possibility of poisoning trees, the market price of the fruit in relation to the costs of spraying will be the deciding factor for, or against, this method of treatment. The apple blossom weevil is another insect difficult to control, and this fact has attracted attention at the East Malling Research Station, where the respective values of different methods of repression have been tested over the period 1921–1924 The only method that proved of value was the trapping of the weevils by means of bands of sacking tied around the trunks of the trees The hibernating weevils lay up in such material, which led to their capture in large numbers Among other noteworthy measures, the application of lime-sulphur against the "big-bud" disease of black currants has given promise when applied at winter strength in March

The control of vegetable root flies, which is occupying the attention of Mr K M Smith at Manchester, appears to be best achieved by the use of odorous substances acting as deterrents, which protect the crop by keeping the insects away One of the best of these preventives is stated to be anthracene oil absorbed in some powder carrier, such as powdered chalk. As the result of Lloyd's work at the Lea Valley Experiment Station at Cheshunt, on fumigation with tetrachlorethane, fumigants of this type have come into prominence in the case of White Fly attacks on plants under glass The application of tetrachlorethane is more expensive than that of hydrocyanic acid gas, but it is a less poisonous remedy for operatives to handle and, in the case of tomatoes, it is no longer necessary to dry off the house prior to treatment in order to avoid injury

The British Isles have up to the present suffered very little from the attacks of imported agricultural pests The factors contributing to this situation are not easy to discover, but the absence of extensive areas of country devoted to single-crop cultivation, together with the practice of crop rotation, afford conditions on the whole unfavourable to the establishment of immigrant forms Furthermore, a variable and, on the whole, inclement climate is probably an important barrier to most species which are denizens of warmer regions. Legislation also serves to keep down the number of alien species which reach this country. On the other hand, sundry foreign insects do succeed in gaining entry and, unless track is kept of them, it is possible that one or other kind may succeed in gaining a permanent foothold During the period covered by the present report several of such species are specially mentioned The most important of these is the Potato Moth (*Phthorimaea operculella* Zell), which has been detected by the Ministry's inspectors in consignments of potatoes imported from Malta and the Canary Isles Since it is an insect with considerable power of adaptation to climatic conditions, the destruction, or re-exportation, of such consignments is a very necessary measure Among other interceptions, larvæ of a beetle of the genus Brachycerus have occurred in consignments of snowdrop bulbs from Smyrna; beans affected by the American Bean Beetle (*Bruchus obtectus* Say) from Minnesota; and peaches from S Africa infested with larvæ of the Mediterranean Fruit Fly (*Ceratitis capitata* Wied)

The outstanding features during the period under review were. (1) the damage occasioned by Fruit Fly and to a lesser degree by Gout Fly in 1922, (2) severe outbreaks of aphids and caterpillars in orchards in 1923, (3) a remarkable absence of most epidemic pests in 1924 In each case the phenomenon observed appears to be largely fostered by the prevailing weather conditions during the seasons concerned, but, until we are in a position to correlate a larger number of years' observations between weather and fluctuations of pest epidemics, such conclusions are necessarily somewhat speculative

Several indigenous species of insects are, for the first time, recorded as injuring crops in England and Wales These include the fly *Chortophila sepia* Mg which did considerable damage to wheat in Cambridgeshire; barley and other cereals in Kent were attacked by the small acalypterate fly, *Diplotoxa limbata* Meig.; old potato sets in N. Wales were infested by a little-known Coccid, *Pseudococcus gahani* Green; in widely separated localities beans suffered from the attacks of several species of root flies of the genus Chortophila and, in Norfolk, the Dock Saw Fly (*Taxonus glabratus*) occasioned considerable injury to apples.

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[1] "Report on the Occurrence of Insect Pests on Crops in England and Wales, for the Years 1922, 1923, and 1924" Miscellaneous Publications, No. 49, Ministry of Agriculture and Fisheries, 1925. 1s. 6d net.

Mr J. C. F. Fryer, the Director of the Ministry's Pathological Laboratory, has produced a report which summarises the activities of his charge in a concise and readable form. The value of documents of this character is usually not immediate, but it is rather that they place on permanent record information for the use of posterity.

A. D. IMMS.

Recent Star Catalogues.

A VERY interesting star catalogue has lately been published in the joint names of Prof. Frank Schlesinger and Ida Barney. It contains 8359 stars between N. Decl 50° and 55°, observed by photography at Allegheny Observatory between August 31, 1915, and July 14, 1916. The number of plates is ninety, their centres all being at Decl. 52½°, and the Right Ascensions increasing by 16 min, or 2·4° of great circle. The measured portion of each plate is a square 5° × 5°: each star appears on two plates; on one to the east of the centre, on the other to the west. The two plates are measured in reversed positions in the micrometer, so that all systematic "magnitude-equation" in R.A. should be eliminated. The object glass is a symmetrical doublet of four lenses, of aperture 103 mm., and equivalent focal length 1·635 metre, giving a scale of 126·2″ = 1 mm A circular stop ensures full illumination over the plate, but reduces the effective aperture to 75·5 mm. Exposure of 25 minutes is found to give strong images to well below the ninth magnitude, except in the case of some red stars.

The places given are referred to those of 1070 stars in the zone, which were observed (each star twice) on the meridian by Prof. R. H. Tucker at Lick Observatory from February 1917 to March 1918. Their places for 1917·0 are given as a supplement to this catalogue. Their average magnitude is 8·5, the same as that of the main catalogue. The latter is referred to the equinox of 1875·0, to facilitate comparison with the Harvard A G. Catalogue of the same zone. This comparison gives determinations of proper motion of all the stars They are printed to the third decimal of 1″, the probable error of each being about 0·015″.

On plotting the "crude" proper motions in R A. for the separate magnitudes and the separate hours of R.A., they form sine-curves the amplitudes of which steadily diminish for the fainter stars owing to greater distance, and the median lines of which get steadily lower. The latter result is due to "magnitude-equation" in the Harvard A.G. Catalogue. The values found for the latter increase from 0·039 s. for magnitude 6·4 to 0·232 s. for magnitude 9·7; these are applied in forming the printed proper motions.

It is welcome news that the zone from Decl. 2° south to 2° north, photographed about 1916, will shortly be published, and that Prof. Schlesinger contemplates the production of similar catalogues for all the A.G. zones.

Volumes 1 and 2 of the Sydney Astrographic Catalogue have lately come to hand. They cover Decl 51° to 53° south, and R.A. 0h to 6h and 6h to 12h respectively. Vol. 3 appeared earlier. It will need fifty-two volumes to cover the entire Sydney zone, which extends from 51° to 65° south The X, Y co-ordinates are printed to the third decimal of a reseau interval; the magnitudes are indicated by letters or numbers on two arbitrary scales, further information is needed to reduce these to the ordinary system. There are 280 stars on a fully printed page (but there are many gaps). Vol. 1 has 25 pages; vol. 2 (the galactic latitude of which is lower) 85 pages.

Explorations in Borneo.

THE fourteenth and fifteenth reports on the Sarawak Museum deal with the years 1915 to 1924. For most of this time it had no curator. Major J. C. Moulton left to join his regiment in February 1915, and his successor, Dr. E. Mjöberg, did not take office until May 1922 He in turn left in December 1924, and was succeeded in February 1925 by Mr. E. Banks. During his curatorship Dr. Mjoberg devoted his energies mainly to collecting, and these two reports give the chief results of his expeditions, of which the chief were those to Mt. Murud and Mt. Poi

Mt Murud had never been visited by a white man, and its precise position was in fact uncertain. It forms the most northern and highest point of the Pamabo Range, which here falls down into a deep valley, bounded by the east-west mountain range Batu Litan. Its height, estimated at 10,000 feet, proves to be 7200 feet, with another peak of 7160 feet. The mountain is built of sandstone, and its slopes are exceedingly rough, full of caves, holes, and crevices, and covered with enormous boulders. The natural difficulties of travel were not lessened by the difficulty of obtaining carriers, owing to the prevalence of an epidemic, and by the inability of the Dyaks to stand the climate of the heights Dr Mjöberg slept for six nights alone on the top ridge, making a proper biological survey. He describes it as "a strange-looking alpine region, with scanty low bushes of leathery appearance, covered with the yellow blossoms of a little epiphytic orchid. Here and there patches of smaller pine trees were seen. Bright scarlet or white flowers of the rhododendron and similar plant types were met with everywhere. Gigantic pitcher-plants (Nepenthes) of strange shape and countless varieties of beautiful, flowering orchids, formed the more striking types of plant life. Only a single little yellow-breasted bird broke the silence of this unknown landscape, never before seen by human eye"

The pitcher-plants just mentioned were responsible for the abundance of a very small frog In the absence of pools, these frogs lay their eggs in the pitchers, and being thus dependent on a minimum of water for passing through their larval stages, they cannot grow larger than one's thumb-nail

Strong lanterns of 250 candle-power were kept alight all night on the summit and attracted many curious moths and other insects. On the highest peak fresh tracks of the wild pig, *Sus barbatus*, were observed.

Descending to the plains of the Kalabit country, and along the Baram River, which was found to have its source on Mt. Murud, Dr. Mjoberg found that the natives of the main plateau had snared for him no less than ten complete specimens of the long-sought Bornean badger.

Of the other expeditions undertaken by Dr. Mjoberg, we need mention only that to Mt. Poi, where he thoroughly surveyed the region above 3500 feet, the highest peak reaching 5600 feet. Here, at heights between 3000 and 3500 feet, were found specimens of the primitive arthropod Peripatus, previously unknown from Borneo. They are comparatively flat and large, and may represent a new species or one of the forms previously known from the Malay Peninsula.

The large collections made by Dr. Mjoberg were distributed by him to such specialists as he could find to undertake the work of determination, but specialists are still required for very many groups, especially among Arachnida, Hymenoptera, Neuroptera, and Pseudoneuroptera.

University and Educational Intelligence.

BIRMINGHAM.—The following appointments have been made: Dr. William H. Wynn, Physician to the General Hospital, Birmingham, to be joint professor of medicine in succession to the late Prof. J. W. Russell; Mr. L. G. A. Sims to be lecturer in electrical engineering in succession to Dr. Randall, who has been appointed to a chair at Johannesburg.

The title of emeritus professor is to be conferred on Sir John Cadman, lately professor of mining, on his resigning his appointment as honorary professor and adviser to the Mining Department.

The following gifts have been received: A legacy of 100*l*. from the late Prof J. W. Russell; a scholarship of 60*l*. per annum from the British Burmah Petroleum Co. for students in the Oil Engineering and Refining Department; valuable models from the Mining Association of Great Britain; and a special weighing machine for the Fuel Treatment Laboratory of the Mining Department from Messrs. W. and T. Avery.

CAMBRIDGE.—The council of the senate has brought forward amendments to the general regulations for prizes and medals, it is proposed that in future, students shall not be permitted to use the same research work for obtaining a research degree and a university prize or medal. As matters stand, the student who has graduated at Cambridge is at a disadvantage when competing with a research student coming from another university; the former has to do three or four years' work before he begins his research, whilst the latter begins on arrival. The regulations for most prizes ordain that candidates must not be of more than a certain number of terms' standing.

OXFORD.—On February 2, Convocation confirmed a decree authorising a special allowance of 200*l*. a year, in addition to his ordinary stipend, to each professor being the head of a scientific department.

Active preparations are going on for the forthcoming visit of the British Association to Oxford on August 4-11.

There will be an election at Keble College, on March 15, to natural science scholarships, one on the Gibbs Foundation and one on the Field-Marshal Gomm Foundation, of the value of 80*l*. per annum. This sum is augmented by the College in the case of the former to 100*l*. per annum. Candidates will be eligible for these scholarships who have not exceeded the age of twenty years on March 15. Inquiries should be addressed to Mr. G. D. Parkes, Keble College. Intending candidates are requested to communicate their names and subjects on or before Saturday, February 24.

THE Committee of Award of the Commonwealth Fund Fellowships announces that applications must reach the Secretary, 50 Russell Square, on or before February 20. The fellowships will normally be tenable at an approved American university for two years. They are open to persons of British birth domiciled in England, Scotland, Wales, and Ireland who are graduates of recognised universities, are unmarried, and not more than thirty years of age. Women as well as men may apply. Provision amounting approximately to 600*l*. per annum will be made for the total expenditure involved during the tenure of a fellowship.

IN our issue of January 30, p. 178, reference was made to the lack of support which is hampering the development of the Imperial College of Tropical Agriculture, Trinidad. It is gratifying to learn from the reply given to a question asked in the House of Commons on February 8 that it has been decided to make a capital contribution of 15,000*l*. towards the cost of the erection of a hostel, a contribution of 3000*l*. towards the general expenses of the College in 1926–27, and, if absolutely necessary, certain further contributions in the three following years.

A THERESA Seessel Research Fellowship, for the promotion of original research in biological studies, is offered by Yale University. The value is 1500 dollars, and preference will be given to candidates who have already obtained their doctorate, and have demonstrated by their work fitness to carry on successfully original research of a high order. The holder must reside in New Haven during the college year, October to June. Applications should be made to the Dean of the Graduate School, New Haven, Conn., U.S.A., before April 1 next, and should be accompanied by reprints of scientific publications, letters of recommendation, and a statement of the particular problem which the candidate expects to investigate

FROM Manchester we have received a pamphlet by Mr. Spurley Hey, the Director of Education, entitled "Value for Money in Education." The gist of this answer to a call for economy in public expenditure on education is that whilst outlay can be stated in cash, the returns which the country is getting for the money spent on education cannot, that the expenditure is bound to increase still further, and that tax- and rate-payers had better pay up and look cheerful instead of criticising what they do not understand and cannot check. Manchester "business men" appear to have made unreasonable demands of the elementary schools: a "special type of arithmetical calculation" or "intimate knowledge of the geography of parts of the world with which their business is connected," or knowledge of foreign languages or shorthand or typewriting. Criticism based on such demands deserves the censure which Mr. Hey administers, but the pamphlet throws little light on such questions as: What, precisely, are the returns, admittedly not estimable in cash, which the administrators of education in Manchester aim at? Is the adjustment of means to ends demonstrably appropriate? And what evidence is there that the returns aimed at are, in fact, being produced?

Contemporary Birthdays.

February 11, 1847. Dr. Thomas Alva Edison
February 11, 1868. Prof. R J Durley, M.Inst.C.E.
February 12, 1872. Prof. A J. Ewart, F.R S.
February 13, 1843. Sir Thomas H. Holdich, K.C M.G.
February 15, 1861. Prof. A. N. Whitehead, F R S
February 16, 1848. Prof. Hugo De Vries, For. Mem R S

Dr. Thomas A Edison was born at Milan, Erie Co, Ohio He began life with scant educational advantages, and these, such as they were, came mainly from his mother's lessons (she was of Scotch descent) and his own omnivorous reading. Early in life he learnt telegraphy, and commenced experimenting in that department and in chemistry and electrical science. He invented the quadruplex and sextuplex telegraphic systems of transmission, the incandescent electric lamp, the phonograph, and a host of devices and appliances which have uses in the daily life of the peoples of all countries. He is a Commander of the Legion of Honour. During the whole of the War period he was engaged in work for the United States Government.

Prof. R J. Durley occupied the chair of mechanical engineering, McGill University, Montreal, 1901–12 He is now a consulting engineer in that city, and secretary of the Engineering Institute of Canada, Montreal. Educated at Bedford Modern School, he studied at University College, Bristol, and afterwards at University College, London. Apprenticed to Earle's Shipbuilding and Engineering Co, Hull, he afterwards became lecturer in mechanical engineering at the Municipal Technical School, Hull He is the author of "Kinematics of Machines" (1908) and of many technical papers.

Prof A J. Ewart, of the University of Melbourne, who occupies there the chair of botany and plant physiology, is a Liverpool man, and was sometime a demonstrator of botany in the university of that city before he graduated at Oxford. Formerly he was well known in various centres in Birmingham as a lecturer and research worker in botanical subjects.

Sir Thomas H. Holdich, traveller and mountaineer, was born at Dingley, Hampshire. He was educated at Godolphin Grammar School and Woolwich Academy, joining the Royal Engineers in 1862 An epitome of much of his career was reflected in 1887 by the award of the Royal Geographical Society's Founders Medal, allotted in consideration of services rendered in carrying out surveys in Afghanistan, also (1884–86) with the Russo-Afghan Boundary Commission, when he conducted operations over an area of 100,000 square miles He was the first Englishman to ascend the Paghmán Range, which lies between Kabul and the passes of the Hindu-Kush. Sir Thomas has consistently upheld the great traditions of the corps of Royal Engineers.

Prof. A N. Whitehead was educated at Sherborne School and Trinity College, Cambridge. Formerly professor of applied mathematics at the Imperial College of Science, South Kensington, he took up in 1924 the post of professor of philosophy at Harvard University, U S A. He was joint author, with the Hon. Bertrand Russell, of that work of fundamental issues, "Principia Mathematica."

Prof. Hugo De Vries, emeritus professor of botany in the University of Amsterdam, was born at Haarlem. He is a foreign member of the Royal Society and the Linnean Society, and Darwin medallist of the former.

Societies and Academies.

London.

Royal Society, February 4.—**W. A. Bone** and **R. Quarendon**: Researches on the chemistry of coal Pt iv. The "residues" obtained after the extraction of coals with benzene under high pressure can be easily oxidised by alkaline solutions of potassium permanganate, yielding a complex mixture of benzenoid carboxylic acids amounting to between 25 and 40 per cent. of the weight of the "coal-residue" treated. These acids include 1, 2, 3, 4 *benzene tetracarboxylic* acid and mellitic (*benzene hexacarboxylic*) acid —**G M B. Dobson** and **D N. Harrison**: Measurements of the amount of ozone in the earth's atmosphere and its relation to other geophysical conditions. Measurements of the amount of ozone in the atmosphere were made almost daily throughout 1925, and a few measurements were also taken during the autumn of 1924. The average amount is about 0·3 cm, which agrees with former measurements A marked connexion is found between the atmospheric pressure and amount of ozone, the latter being large in cyclonic and small in anti-cyclonic conditions. There is a well-marked annual period with a maximum in spring and minimum in late autumn. The probable error of observation is about 0·005 cm of ozone.—**C. Chree**: Atmospheric ozone and terrestrial magnetism. Using the results of the paper above, there appears to be a decided association of magnetic disturbance and higher values of ozone. Owing to the tendency to sequences of high ozone figures and of days of magnetic disturbance, it is difficult to say exactly how synchronous the phenomena are. The figures suggest that the high ozone figure precedes the crest of magnetic disturbance —**J. S Owens**: Condensation of water from the air upon hygroscopic crystals Deliquescence of crystals of pure salts depends upon the vapour pressure of their saturated solutions, while mixed salts, as found in air, behave in a different manner from pure salts. It is usually assumed that before fog can be formed the air must be saturated, or nearly so; but it is demonstrated that all the examples of crystals obtained from the air would become liquid in air very much under-saturated Thus the crystals from Algarve (Portugal) collected water at 69 per cent. relative humidity at 56° F; crystals from the neighbourhood of the mouth of the St Lawrence deliquesced at about 77 per cent relative humidity at 56° F. Crystals obtained in Bournemouth deliquesced at about 67 per cent relative humidity at 62° F, indicating that it is not necessary for air charged with such crystals even to be near saturation for a fog of liquid drops to form —**T. H. Havelock**: Wave resistance. some cases of unsymmetrical forms. The type of asymmetry is suggested by the general effect of fluid friction in reducing the wave-generating properties of the rear portion of the model. Pairs of models are examined in which one model is symmetrical fore and aft, while in the other the rear portion is curved off into more of a streamline form This produces a marked decrease in the magnitude of the interference phenomena.—**H. Jeffreys**: On the formation of water waves by wind. On the hypothesis that, in a first approximation, water waves may be considered irrotational, viscosity and other factors tending to change the amplitude being small, the conditions of growth of waves under the action of wind, even when the depth is finite and surface tension is allowed for, have been investigated. The rate of decay of waves, in the absence of wind, is independent of the depth and the surface tension. The easiest waves for a wind to raise are always two-dimensional, and are gravity waves, not ripples The wind velocity needed to produce waves is greater in shallow water than in deep water. The longer waves on shallow water (less than about 1 cm deep) are, however, so much affected by viscosity that the hypothesis is invalid for them; it seems they can in no case be formed by wind The waves produced on shallow water must therefore be very short, about 2-3 cm. say, which agrees with observation.—G. T **Morgan**, W. J. **Hickinbottom**, and T. V. **Barker**: Stereoisomeric diaryl-*β*-*γ*-diamino-*n*-butanes The secondary diamines of the general type $Ar.NH.CH(CH_3).CH(CH_3).NH.Ar$ contain two asymmetric carbon atoms, either mirror images of each other or absolutely identical. Like tartaric acids these bases should exist in an internally compensated *meso*-form, as well as an externally compensated mixture, potentially resolvable into optically active modifications The most fully investigated series of compounds are those containing the *p*-tolyl residue:

$$CH_3.C_6H_4\ NH.CH(CH_3).CH(CH_3).NH.C_6H_4.CH_3,$$

and the study of these bases affords a highly satisfactory confirmation of the requirements of stereochemical theory —G. T. **Morgan** and G. R. **Davies**: Antimonial analogues of the cacodyl series Methyl arsenicals were first discovered by Louis Claude Cadet de Gassicourt in 1760 (*Paris, Acad., Sci. Mém. Div. Sav.* t. 3, p. 623). Similar experiments on organic compounds of antimony led to the preparation of tertiary stibine and other derivatives by Lowig and Schweizer and by Landolt, but the antimonial analogues of the cacodyl series have so far eluded isolation. The thermal decomposition of trimethylstibine dihalides has now been investigated, the following reaction having been generalised when X is chlorine, bromine, or iodine.

$$(CH_3)_3SbX_2 = (CH_3)_2SbX + CH_3X.$$

This process affords the means of proceeding from the tertiary to the secondary series of organic antimonials.—G. T. **Morgan** and V. E **Yarsley**: Dimethylstibine cyanide, an analogue of cacodyl cyanide. When anhydrous reagents are used, cyanogen bromide combines readily with trimethylstibine dissolved in light petroleum to form trimethylstibine cyanobromide, a white crystalline compound. This is relatively stable, and is only decomposed *in vacuo* at high temperatures, when dimethylstibine cyanide is obtained as a colourless crystalline compound, m p. 113°-114°. This cyanide, the analogue of Bunsen's cacodyl cyanide, fumes on exposure to air, with the formation of white infusible trimethylstibine oxycyanide.

Faraday Society, January 18 —B. B. **Banerji**: The electrode capacity and resistance of electrolytes for a wide range of frequencies. The laws of variation suggested by Haworth and by Warburg are satisfied only through small ranges of frequency; a law is given which holds throughout the range investigated. The hypothesis of double leaky capacities at the electrodes has been put forward to explain this law. The existence of the capacities is ascribed, one to the double layer and another to the concentration changes brought about by the transport phenomena. The thickness of the double layer calculated from the value of the double-layer capacity is of the proper order and consistent with the value found by other methods.—J. A. V. **Butler**, W. E. **Hugh**, and D. H. **Hey**: A note on the effect of the electrode material on oxidation potentials. The independence of oxidation potentials of the electrode material, when this takes no appreciable part in the cell reaction, is confirmed.—R. E. W. **Maddison**: The electromotive behaviour of cupric oxide. (1) The behaviour of the electrode Pt/Cu_2O, CuO, N-NaOH has been re-examined Initially, it gives a relatively positive P.D, which gradually becomes more negative The initial and final P D's depend on the temperature of preparation of the oxide, and on the duration and method of heating.—A. **Highfield**: The colloidal properties of nitrocellulose sols in mixed solvents. Nitrocellulose and its solvents contain both strongly and weakly polar groups Mixed liquids are solvents if they contain these two classes of groups balanced in suitable proportions, and this conclusion holds whether the ingredients of the mixtures are solvents or not. The relation between the composition of solvent or solute and the viscosity of nitrocellulose sols has been investigated, and the results are in line with the conclusions reached from solubility considerations.—E. P. **Perman** and T. **Lovett**. (1) Vapour pressure of concentrated aqueous solutions of urea. These are given at the temperatures 40·02°, 60·28°, 70·39°, and 80·1° C., and the densities up to a concentration corresponding very nearly with saturation are given at the same temperatures. Van Babo's law does not hold for aqueous solutions of urea. The results indicate a normal molecular weight and no hydration for urea in aqueous solution. (2) The heats of dilution of concentrated solutions of urea at various temperatures. An original method is described by which these can be measured From the results obtained it is possible to obtain the heat of dilution as defined by Kirchhoff's equation, the total heat of dilution between any two concentrations, and the relation between the heat of dilution and the concentration. A new method of determining solubilities is suggested —W. **Taylor**: A note on kinetic activation as a factor in gas reactions.

CAMBRIDGE.

Philosophical Society, January 18.—H. F **Baker**: On chains of two-two relations, and the theory of elliptic functions —G. C **Stewart**: The aberrations of a symmetrical optical system. The geometrical aberrations are considered in detail for the first three orders—both for the paraxial image plane and also for out-of-focus planes. Aberrations of all orders fall severally into one or other of two general types.—W. **Burnside**: On a group of 1440 birational transformations of four variables that arises in considering the projective equivalence of double sixes —P. L. **Kapitza**: Over-tensions in a condenser battery during a sudden discharge. If a large condenser battery made of Leyden jars is discharged through a small self-induction, the tension across the jars reaches sometimes very large values, which may break the insulation across the Leyden jars. A photograph of the spark in this case shows that the current from the jars goes through the main circuit only for a few half periods. Due to the self-induction of the connecting wires, oscillations are produced in the battery between the Leyden jars, which account for the over-tension.—H. S **Hirst**. Photocatalysis at mercury surfaces. A mercury surface, irradiated by ultra-violet light strong in the line $\lambda = 2536 \cdot 7$ Å U., exerts a catalytic influence on the photochemical union of hydrogen with gases such as oxygen, ethylene, and carbon monoxide. The velocity of reaction is to the first order proportional to the area of surface exposed. A film of mercuric oxide on the mercury forms only in the presence of both hydrogen and oxygen. In the combination of nitrogen and hydrogen, hydrazine and ammonia have been identified, and in the case of oxygen and hydrogen, hydrogen peroxide and water. It is suggested the reactions proceed by steps The catalytic efficiency of the surface depends on its cleanness and is cut down by poisons —P. **Bracelin**. The period of decay of RaB and RaC Measurements of the saturation currents produced between two parallel plates by a source of radium C give a transformation constant of $(3 \cdot 514 \pm 0 \cdot 007) \times 10^{-2}$ min $^{-1}$ for radium C, corresponding to a half value period of $19 \cdot 72 \pm 0 \cdot 04$ minutes Similar measurements have been made on sources of radium active deposit and the decay compared with the values calculated by assuming the above period for radium C and trying various values for that of radium B. The experimental results indicate a value between 26·7 to 26·8 minutes

EDINBURGH.

Royal Society, January 25 —T **J. Jehu** and **R. M. Craig** Geology of the Hebrides Pt iii North Uist and Benbecula The outstanding feature is the belt of crushed and sheared rocks traceable along the eastern side of Benbecula and North Uist, and separated by a thrust-plane from the relatively undisturbed gneisses forming the western and greater part of the area. This forms a continuation of that along the eastern side of South Uist It is made up of crushed gneisses, mylonites, and flinty crush material intermixed, in contrast to the definite zones traceable in the case of South Uist The dominant gneisses of the western area are acid biotite-gneiss, hornblende-biotite-gneiss, hornblende-gneiss, and garnetiferous hornblende-gneiss. Pyroxene and hornblende granulites often, rich in garnets are intrusive into the dominant gneisses Bands of pegmatite are frequent, sometimes yielding good graphic granite. Ultra-basic rocks in bands converted into actinolite schists occur especially in the isles of Berneray and Pabbay. All these types are altered igneous rocks of the Archæan complex Minor intrusions of Tertiary age are much less frequent than in the more southern isles The three Maddys, rocky islets at the entrance to Loch Maddy, are portions of an olivine-dolerite sill. Evidences of recent subsistence are afforded by submarine peat off the coast and by the drowning of fresh-water lochs.—T. M **Finlay**: The Old Red Sandstone of Shetland A new fossil zone occurred a short distance below the conglomerate in the south-eastern area of the Old Red Sandstone This has yielded three species of fish, *Dipterus valenciennesi*, Microbrachius sp nov., and a new genus *Stegotrachelus finlayi*, a palæoniscid of extreme interest as being the earliest of the family known in complete specimens from the Devonian, and the first to be recorded from the Old Red Sandstone of Europe The genus has been described and figured by Smith Woodward and White —J. Kaye **Charlesworth**. (1) The glacial geology of the southern uplands of Scotland, west of Annandale and Upper Clydesdale The lines of ice-flow over the region by striæ, drumlins, and erratics has been traced and the position of the ice-edge ascertained at five successive periods of the retreat by the correlation of the moraines associated with the major glaciers. There is evidence of re-advances in connexion with two of these stages. (2) The great re-advance kame-moraines of the south of Scotland and some later stages of retreat There is an important line of re-advance of the ice around the coastal areas of north-east Ireland from the mouth of Lough Foyle to the head of Belfast Lough, by the Bride Hills of the Isle of Man and the Cumberland coast. A later position of the ice-margin is from St Abb's Head along the northern slopes of the Lammermuir and Moorfoot Hills, by Muirkirk and to the east of New Cumnock, and again at Stranraer and in the Rhinns of Galloway. At this stage, corrie glaciers lingered in the Lammermuir Hills, the Tweed below Broughton was ice-free, and the highland ice was confluent over south Ayrshire with the southern upland glaciers of (1) The North Ireland moraine is correlated with the Baltic moraine of N Germany, the later moraines with the Ra moraines of Scandinavia and the "post-glacial stages" of the Alps —A. E. M **Geddes**. Distribution of electric force in high-voltage discharges. An investigation by F. W Aston proved that for electric discharges in vacuum tubes, the potential across the dark space is equal to that across the tube, with voltages less than 1000 volts. It is now shown that, with voltages more than 13,750 volts, only a part of the total voltage is confined to the dark space, about 0·25 of the excess of the total voltage, more than 13,750 being found in the negative glow

PARIS

Academy of Sciences, December 28 —**Charles Richet, Gardner, and Goodbody**: The effects of salts of zirconium, titanium, and manganese on nutrition These metals were administered to dogs as citrates mixed with the food. Neither zirconium, titanium, nor manganese had any toxic effect Titanium and zirconium, especially the latter, appeared to have a slightly favourable effect on nutrition. The results with manganese were irregular —**Léon Guillet** The tempering of light aluminium-copper alloys containing more than 5 per cent of copper.—**Ch. Depéret** and **J Savornin**: The discovery of a fauna of Albian vertebrates at Timimoun (Western Sahara) —**E. Mathias**: Contribution to the study of fulminating materials The colour. Chemical heterogeneities The theory of ball lightning —**G. A Boulenger**: Remarks on the importance attached to the mode of insertion of the carpels for the classification of the species of the genus Rosa —**L Cuénot** The signification of homochromy in some marine animals —**Gaston Julia**. The series of rational repeated functions —**A. Zygmund**: The summation of trigonometrical series and those of powers by typical means —**A Bloch** Some theorems on integral and meromorph functions of a variable —**R. Gosse**. The equation of the deformation of surfaces —**J Cayrel** The properties of lead dioxide as a detector Lead dioxide, in combination with points of various metals (magnesium, zinc, tin, aluminium), can be used as a detector in wireless telephony.—**E Fromy** The relation between the Wiedemann effect and the Joule effect —**A. Dauvillier**: The biological action of X-rays of various wave-lengths. A discussion of the correct interpretation of some recent measurements of A Dognon. It is concluded that the large difference found by Dognon in the biological action was not justified by the experiments and that in reality the radiations $\lambda = 0 \cdot 22$ and $\lambda = 0 \cdot 7$, for equal energy absorbed, have the same biological action.—**Jean Rey** The brilliance and luminous flux of carbons of high light intensity, for projection of electric light The electric light carbons contain a central core of rare earths (salts of cerium or titanium). The illuminating power per square millimetre is very high, but falls far short of the figures claimed by the manufacturers —**Mme. J. S Lattès** and **Georges Fournier**: The absorption of the β-rays by matter —**E Darmois**. A case of mutarotation. Application to the study of the saponification of ethyl oxalate by water or dilute acids —**R de Mallemann**: The calculation of Verdet's constant in the molecular theory —**René Dubrisay** Some phenomena of capillary chemistry. Benzene solutions of fatty acids (palmitic, oleic, stearic) were allowed to run from a burette into water or weak soda solutions at different temperatures The variations in the surface tension were deduced from the size of the drop.—Charles **Grard**: The influence of the thermal zone of work on the selection of steels for the valves of aviation motors. A study of the properties of chrome-silicon steels. A steel of the type carbon 0·4 per cent, silicon 2·5 per cent, chromium 12 per cent. gave the best results on these tests, and a trial of this alloy on a 450 H.P. engine gave very satisfactory results.—Raymond **Delaby** and Maurice Marie **Janot**: Cyclohexylglycerol.—G **Georgalas** and N **Liatsikas** The new eruption of the Santorin volcano (1925). A detailed account of the phenomena observed between August 23 and October 13.—P. **Lasareff**: The results of geophysical work in the domain of the magnetic anomaly of Koursk. The magnetic anomaly is shown to be due to large deposits of iron ores The quantity of iron, calculated as metal in this region, is of the order of 2×10^{10} tons.—Rafael de **Buen**. The genesis of the Rias.—Henry **Hubert**. The evolution of very extended masses of cumulo-nimbus in Western Africa.—P. **Allorge**: The variations of the hydrogen ion concentration in some Sphagnum peats in the centre and west of France. For the peats examined the *p*H values were found to be between 3·9 and 6·8.—A. **Maige**: The unilocular or plurilocular amylogen reaction of the plasts.—André **Dauphiné**: Experimental demonstration of the vascular ratio between the leaf and the root. It was shown by G Chauveaud in 1921 that the appearance of new leaves is accompanied by the differentiation of new conducting elements in the stem and root. This is confirmed by experiments described by the author in which lesions resulting in the suppression of certain leaves correspond in the root to the absence of vascular groups.—R **Morquer**: The biology of *Mucidula mucida*.—Raymond **Hamet**: A type of medullary cribo-vascular formations new for the family of the Crassulaceæ.—M. **Mascré**: The staminal periplasmodium of the Commelinaceæ.—M. **Bridel** and C. **Charaux**: The biological method of research, in plants, on glucosides hydrolysable by rhamnodiastase. The ferment rhamnodiastase, extracted from various species of Rhamnus, causes a partial hydrolysis of glucosides, some of the molecules of glucose remaining combined together in the form of complex glucides (primeverose, rutinose, rhamninose, etc.) Results are given of the application of this ferment to various plants.—H. **Colin** and A. **Grandsire**: The chemical characters of green leaves, yellow leaves, and red leaves. Compared with normal green leaves, red autumn leaves are richer in sugars and in free organic acids, are less mineralised, and are partially decalcified. The yellow leaves are poor in sugar, but rich in water and mineral salts.—Michel **Durand**: The influence of light on the formation of tannins.—Léon **Bertin** and Fernand **Angel**. The plankton and planktonic food of the fishes of the Lake of Geneva.—Ch **Hollande**: The urate cells of acridian Orthoptera and the genesis of these urates.—Emile F. **Terroine** and Mlle. Anne Marie **Mendler**: The influence of the addition of ternary food substances to milk on the magnitude of the nitrogen retention in the course of growth. The results of experiments on the growth of sucking pigs fed with skimmed milk, whole milk, the latter alone or mixed with additional fatty or starchy material. The addition of fat or of carbohydrates to the milk caused a marked improvement in the proportion of proteid retained and utilised by the animal. Whole milk did not prove to be the ideal food.—Mme. L. **Randoin** and Mlle. A. **Michaux**: Glycogen reserves and arterial glycæmia (effective and proteidic) in the course of experimental scurvy.—Marcel **Francois**, I. **Meyerson**, and Henri **Pieron**: The latent time of reactions of equilibration to sudden longitudinal accelerations.—H. **Barthélémy**: The action of saline and aqueous extracts of eggs of the same species on the spermatozoids of *Rana fusca*.—P H. **Fischer**: The influence of light and of the renewal of air on the awakening of snails (after hibernation). The humidity of the air is not a necessary condition of the awakening of snails This is accelerated by light and by renewal of air.—F **Vlès** and A. de **Coulon**: The physico-chemical properties of certain constituents of serum.—Jivoin **Georgévitch**: The structure of the spore of *Pleistophora periplanetæ*.—Raoul **Bayeux**: Hæmatolysis and hæmatopoiasis at very high altitudes and in air experimentally rarefied. Breathing rarefied air determines a toxic hæmolysis the clinical result of which is mountain sickness It is possible that at medium heights (3000 feet) the blood may be purified by the destruction of fragile or unhealthy red corpuscles, replacing them by fresh healthy corpuscles.—Stefan **Jellinek**: Electrical accidents and artificial respiration. The author insists on the importance of immediate and prolonged artificial respiration in cases of the victims of electric shock.— — **d'Arsonval**: Remarks on the preceding communication. The views of M. Jellinek are in complete agreement with those published by the author so far back as 1885. A victim of electric shock should be treated like a person apparently drowned. As regards the method of artificial respiration, the best is that of Schaefer, possibly combined with oxygen inhalation

January 4.—H. **Deslandres**: Obituary notice of Hildebrand Hildebrandsson.—A. **Cotton** and R. **Descamps**: A photographic spectro-polarimeter for the ultra-violet. The instrument described is based on the principle that the movement of rotation of the analyser produces a displacement of the image recorded on the sensitised plate.—Julien **Costantin** and Joseph **Magrou**: Contribution to the study of the roots of alpine plants and their mycorhiza.—C. **Camichel**, L. **Escande**, and M. **Ricaud**: The determination of velocities in liquids and the paradox of Du Buat. A method of applying the Pitot tube in which, instead of measuring the difference of pressure, a compensating pressure is set up by means of a rotatory pump. Velocities of the order of 5 cm. per second can be measured.—E. **Mathias**: Contribution to the study of fulminating material The black and white globes without light of their own A development of a theory of globular lightning.—Maurice **Gevrey**: The resolution of the problems at the limits without Green's functions.— — **Mandelbrojt**: Some generalisations of theorems on series which admit of interruptions.—E. F **Collingwood**: A theorem of M. Valiron.—Julius **Wolff**: The iteration of holomorph functions in a region, the values of which belong to that region.—R. **Chambaud**. The internal potential in thick circular arches and the idea of average slipping deduced from it.—E G **Barrillon**. Concerning the part of the resistance to towing of a float due to the formation of a field of waves.—V. **Bjerknes**: The temperature of sunspots.—Th. **Vautier**: The propagation of short sound waves and of low pressure.—F. **Holweck**: The critical potential K of neon This was found to be 862 volts.—Jean **Thibaud**: The determination in absolute measure of the wave-lengths of X-rays by means of a reflection grating traced on glass. The spectroscopy of the X-rays is based on the diffraction of these radiations in crystallised media which act as gratings, of which the constant, the reticular distance *d*, can be calculated from certain hypotheses due to Bragg. The author describes experiments with a glass diffraction grating ruled with 200 lines to the millimetre and gives a reproduction of one of the spectra obtained The wave-length for the copper line $K\alpha$ was thus found to be 1·540 Å.U., in good agreement with the 1·538 Å.U. given by the crystal method.—Pierre **Sève**: A spectrograph with a non-inclined plate.—P. Mondain **Monval**: The thermal properties of viscous sulphur. The experimental results are summarised in a diagram in which the quantities of heat given out on cooling are plotted against the temperatures to which the sulphur has been heated. The curve is discontinuous, with four branches corresponding to orthorhombic, monoclinic, liquid, and viscous sulphur. The transformation of liquid sulphur into viscous sulphur at 160° C. is accompanied by an absorption of 2·8 calories per gram.—F. **Taradoire**: The rapid oxidation of drying oils and antioxygens.—L. **Bert** and P. Ch. **Dorier**: A complete synthesis of thymol starting from isopropyl alcohol. A diagram is given of the fifteen steps in this synthesis, together with the yield of each successive operation.—G. **Hugel**: Heterocyclic combinations containing pentavalent iodine or bromine.—**Orekhoff** and **Tiffeneau**: The transposition of trisubstituted aldehydes into disubstituted ketones. Details of transpositions of the type RRR′.C.CHO→RR.CH.CO.R′.—Joseph **Péneau**: The presence of Clymenia and the extension of the upper Devonian in the south-east of the Armorican massif.—E. A. **Martel**: The Bertarelli abyss (Istria), 430 metres deep.—Const. A. **Kténas**: The enclosures and ashes of Fouqué Kameni.—R. **Bureau**: The prediction of the weather and the daily variation of atmospherics.—P. **Lavialle**: The development of the anther and pollen in *Knautia arvensis*.—Pierre **Dangeard**: The flora of the peridineans of the western Channel.—G. **Nicolas**: A new and certain example of parasitism in Hepatica (*Marchantia polymorpha*).—Louis **Daniel**: Heredity of the property of second flowering in grafted plants.—Jacques **Pellegrin**: The biology of the omble trout of the Middle Atlas (*Salmo Pallaryi*).—André **Migot** and Adolf **Portmann**: *Chondranthus denudatum*, a new species from the Mediterranean.—Auguste **Lumière** and Henri **Couturier**: The toxicity of serum put in contact with starch. Serum from the guinea-pig, digested with rice starch at 37° C. and centrifuged, causes death by anaphylactic shock when injected into an animal of the same species. It was found, however, that the symptoms were attenuated when the centrifugation was prolonged for half-an-hour, and if the serum is centrifuged (tangential velocity 96 metres per second) for 50 minutes, the serum becomes completely innocuous. The author points out the bearing of these experiments on his theory of anaphylaxis, according to which the toxic agent is in all cases a flocculate more or less visible, which is insoluble and acts by its physical properties.—Jean **Roche**: The action of temperature on respiration *in vitro* of the tissues of homeotherms and poecilotherms.—Mme. L. **Randoin**, Mlles **Asselin** and **Charles**: Reproduction, growth, and food equilibrium.—Marcel **Duval** and Marcel **Prenant**: The molecular concentration of the internal medium of *Ascidia mentula*. Contrary to what has been observed with other marine invertebrates, the blood of this Ascidian is not isotonic with sea water, but is sensibly hypertonic, the difference between the freezing points of the two media being 0°·10. The proportion of chlorine in the blood is higher than that in the surrounding sea water.—J. E. **Abelous** and L. C. **Soula**: The cholesterogenic function of the spleen; the influence of the internal secretion of the spleen on cholesterogenesis in the muscles.—Edouard **Chatton** and André **Lwoff**: The structure and the evolutive cycle of the Infusoria of the cast skins of Crustacea and their place amongst the Fœttingeriideæ.—Jivoin **rgévitch**: The evolutive cycle of *Pleistophora iplanetæ*.

Official Publications Received.

Aeronautical Research Committee. Reports and Memoranda, No. 977 (Ae. 191): An Experimental Investigation into the Properties of certain Framed Structures having Redundant Bracing Members. Report No. 3. By Prof. A. J. Sutton Pippard. (S. 2 g. Strength and Design, general, 67—T. 2114.) Pp. 12+1 plate. 6d. net. Reports and Memoranda, No. 979 (E. 15). Closed Vessel Explosions of Mixtures of Air and Liquid Fuel (Petrol, Hexane and Benzene) over a wide Range of Mixture Strength, Initial Temperature and Initial Pressure. By R. W. Fenning. (I.C.E. 369, I.C.E. 396, I.C.E. 440, I.C.E. 440A.) Pp. 28+16 plates. 2s. 6d. net. (London: H.M. Stationery Office.)

Dirección general del Instituto Geográfico. Anuario del Observatorio de Madrid para 1926. Pp. 520. (Madrid.)

Torquay Natural History Society. Transactions and Proceedings for the Year 1924–5. Vol. 4, Part 3. Pp. 199–285. (Torquay.)

Ministry of Finance, Egypt: Survey of Egypt, Geological Survey. The Geography and Geology of Makalla (South Arabia). By O. H. Little. With two Appendices: (i) Description of Fossils from South Arabia and British Somaliland, by Prof. G. Stefanini; (ii) Note on some Terrestrial Mollusca from the Hinterland of Makalla, by P. Pallary. Pp. xi+250+36 plates. (Cairo: Government Publications Office.) 50 P.T.

The Journal of the Institute of Metals. Vol. 34. Edited by G. Shaw Scott. Pp. xi+799+33 plates. (London.) 31s. 6d. net.

Society for the Preservation of the Fauna of the Empire Journal. New Series, Part 5. Pp. 78. (London: H. F. and G. Witherby.) 2s. 6d. net.

Proceedings of the Society for Psychical Research. Part 97, Vol. 36, January. Pp. 77. (London: Francis Edwards.) 5s. net.

Department of Commerce: Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 297: A Statistical Study of Conditions affecting the Distance Range of Radio Telephone Broadcasting Stations. By C. M. Jansky, Jr. Pp. 639–650. 5 cents. Circular of the Bureau of Standards, No. 280: Standard Time Throughout the World. Pp. 9. 5 cents. Scientific Papers of the Bureau of Standards, No. 515: Thermal Expansion of Tungsten. By Peter Hidnert and W. T. Sweeney. Pp. 481–487. 5 cents. (Washington: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 31: Medical Education, 1923–1924. By Dr. N. P. Colwell. Pp. 14. (Washington: Government Printing Office.) 5 cents.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 64: Notes on Egyptian Coccidae, with Descriptions of new Species. By W. J. Hall. Pp. v+31+6 plates. (Cairo: Government Publications Office.) 5 P.T.

University of California Publications in American Archaeology and Ethnology. Vol. 21, No. 5, and Vol. 21, No. 6: The Uhle Pottery Collections from Moche, and The Uhle Pottery Collections from Supe. By A. L. Kroeber. Pp. 191–234+plates 50–69+235–264+plates 70–79. (Berkeley, Calif.: University of California Press.) 1.25 dollars.

Publikationer fra det Danske Meteorologiske Institut. Aarbøger. The Pycnosonde: an Apparatus for Hydrographic Soundings. By D. la Cour. Pp. 18. (København: G. E. C. Gad.)

Diary of Societies.

SATURDAY, February 13.

North of England Institute of Mining and Mechanical Engineers (at Newcastle-upon-Tyne), at 2.30.—P. S. Lee: Haulage Accidents.—S. Burns: Winding Costs: A Plea to the Purchaser of Electric Winding Plant for Withdrawal of Stipulations which are not Conducive to Economical Working.—Papers Open for Further Discussion:—J. S. Carson: A System of Mechanical Coal-mining combined with the Adoption of Systematic Timbering, using Composite Steel Props.—Prof. H. Briggs and Dr. J. N. Williamson: Experiments on Fan Casings and Fan Inlets.

Royal Institution of Great Britain, at 3.—Sir Walford Davies: The Triad and the Perfect Fourth (2). Their Uses from Hucbald to the Present Day.

British Psychological Society (at Bedford College for Women), at 3.—Dr. E. H. Magson: Judgments of Intelligence based upon Interviews.—R. J. Bartlett: Indications of a Logarithmic Law in Learning.

Institute of Transport (North-Eastern Local Section) (at Newcastle-upon-Tyne), at 3.—D. S. Burn: Notes on Railway Organisation.

Mining Institute of Scotland (at Heriot-Watt College, Edinburgh), at 3.—Dr. J. Parker: The Adjustment of Ropes on Bi-Cylindro-Conical Drums.—D. C. Gemmell: The Problem of In-bye Transport.—Papers open for discussion:—The Report of the Institution Committee on Ventilation of Mines; Notes on Cleat in the Scottish Coalfields, by Prof. R. W. Dron; Coal Cutting by Machinery and Conveyers in Scottish Mines, by G. L. Kerr.

Scottish Junior Gas Association (at Royal Technical College, Glasgow), at 7.—A. Philip: Municipal Gas Undertakings: Finance and Accounting.

MONDAY, February 15.

Royal Geographical Society (at Lowther Lodge), at 5.

Royal Society of Medicine, at 5.—Prof. G. R. Murray, H. Tilley, F. W. Broderick, and others: Discussion on Focal Sepsis as a Factor in Disease.

Royal College of Surgeons of England, at 5.—S. Cade: Cholecystography.

British Institute of Philosophical Studies (at Bedford College for Women), at 5.30.—Prof. J. Johnstone: Heredity and Development: Theory of the Germ-plasm.

Electrical Association for Women (at 15 Savoy Street), at 7.—W. E. Bush and Miss Hodge: Electric Light in the Home.

Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—P. Dunsheath: Dielectric Problems in High-Voltage Cables.

Institution of Electrical Engineers (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.15.—C. W. Blacklock: Paper.

Institution of Automobile Engineers (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—T. D. Carpenter: Motor Coachbuilding Problems.

Aristotelian Society (at University of London Club, 21 Gower Street), at 8.—R. G. Collingwood: Some Perplexities about Time.

Royal Society of Arts, at 8.—Dr. G. W. C. Kaye: The Production and Measurement of High Vacua (Cantor Lectures) (1).

Medical Society of London, at 9.—Dr. E. Farquhar Buzzard: The Principles of Treatment in Relation to Diseases of the Nervous System (Lettsomian Lectures) (1).

Chemical Industry Club.

TUESDAY, February 16.

Royal Medico-Psychological Association (at 19B Tavistock Square), at 2.30.—Dr. Isabel Robertson: Blood and Vascular Conditions in Psychoses.

Royal Anthropological Institute (Edinburgh and the Lothians Branch) (at Synod Hall, Edinburgh), at 5.—Rev. E. M. K. Hall: Life and Legend in the New Hebrides.

Royal Society of Medicine (Therapeutics and Pharmacology Section) (Laboratory Meeting) (at Guy's Hospital), at 5.—Prof. C. S. Gibson: A New Series of Arsenical Compounds.—Prof. C. S. Gibson and Prof. A. L. Gibson: Demonstration of New Cryoscopic Apparatus.—Dr. E. P. Poulton: A Method of administering Oxygen without Waste.—Dr. N. Mutch: Differential Adsorption of Dyes by Kaolin and Aluminium Hydroxide.

Royal Institution of Great Britain, at 5.15.—Prof. J. Barcroft: The Egg (1): Introductory.

Royal Statistical Society (at Royal Society of Arts), at 5.15.—H. C. Scott: The Rignano Scheme in its Administrative Aspects.

British Institute of Philosophical Studies (at Bedford College for Women), at 5.30.—Prof. L. J. Russell: Matter, Life and Mind.

Royal Photographic Society of Great Britain, at 7.—W. Day and others: Discussion on Claims to Motion Picture Invention.

Staffordshire Iron and Steel Institute (at Dudley), at 7.—Discussion on Iron *v.* Steel.

Institution of Electrical Engineers (North-Western Centre) (jointly with Institution of Post Office Electrical Engineers) (at Milton Hall, Deansgate, Manchester), at 7.30.—E. H. Shaughnessy: Wireless (Lecture).

Royal Anthropological Institute, at 8.15.—A. M. Hocart: The Power of Miracles.

British Institute of Philosophical Studies (at Royal Society of Arts), at 8.15.—Sir Frederick Lugard, Hon. H. A. Wyndham, and Dr. M. Ginsberg: Discussion on The Problem of Colour in relation to the Idea of Equality.

WEDNESDAY, February 17.

Institute of Hygiene, at 3.30.—Dr. Risien Russell: The Prevention of Nervous Affections in the Young.

Royal College of Surgeons of England, at 5.—Dr. A. Piney: The Importance of Hæmatology in Surgery.

British Institute of Philosophical Studies (at University of London Club), at 5.30.—Hon. Bertrand Russell: Physics and Psychology.

Institution of Civil Engineers (Students' Meeting), at 6.—D. S. Matheson: Subaqueous Tunnelling in Compressed Air, with Reference to Barking Power-Station Cable Tunnel under the River Thames.

Institution of Electrical Engineers (South Midland Centre) (at Birmingham University), at 7.—H. Parodi: The Electrification of the Paris Orleans Railway.

Association of Mining Electrical Engineers (at Royal Technical College, Glasgow), at 7.—A. Dixon: Electrification of the Hodbarrow Iron Ore Mines.

Royal Meteorological Society, at 7.30.—Dr. T. H. Somervell: On Temperature at High Altitudes. Meteorological Observations of the Mount Everest Expedition, 1924.—Dr. Vaughan Cornish: Observations of Wind Wave and Swell on the North Atlantic Ocean.—Commdr. L. G. Garbett: Admiral Sir Francis Beaufort and the Beaufort Scales of Wind and Weather.—Dr. J. Bartels: On the Determination of Minute Periodic Variations.

Royal Microscopical Society, at 8.—F. Haynes: (*a*) A Note on a Rapid Method of Staining in Heidenhain's Hæmatoxylin; (*b*) A Note on an Improved Method of Preparation of Weigert's Elastin Stain.—Dr. A. Piney: The Principles of Hæmatological Differentiation.—Dr. R. S. Clay and T. H. Court: The Wilson Microscopes.

Royal Society of Arts, at 8.—J. H. Taylor: The Propagation of Electric Waves.

C.B.C. Society for Constructive Birth Control and Racial Progress (at Essex Hall, Essex Street), at 8.—R. B. Kerr: What Malthus said and what Malthusianism is To-day (Lecture).

Institute of Chemistry (London Section).

Society of Glass Technology (at Sheffield).

THURSDAY, February 18.

Royal Society, at 4.30.—Prof. A. Fowler: The Spectrum of Ionised Oxygen (O II).—Prof. W. A. Bone and F. R. Weston: New Experiments upon the Combustion of Well-dried Carbon Monoxide and Oxygen Mixtures. Part I.—Prof. W. A. Bone, R. P. Fraser, and D. M. Newitt: New Experiments upon the Combustion of Well-dried Carbon Monoxide and Oxygen Mixtures. Part II.—C. S. Beals: Quartet Terms in the Arc Spectrum of Copper.—*To be read in title only*:—J. H. Brinkworth: The Ratios of the Specific Heats of Nitrogen at Atmospheric Pressure and at Temperatures between 10° C and −183° C.—W. R. Dean: The Elastic Stability of a Corrugated Plate.—E. Newbery: The Controlling Factors of Transfer Resistance.

Linnean Society of London, at 5.—Prof. F. O. Bower: A Scheme of Phyletic Grouping of Ferns.

Royal Institution of Great Britain, at 5.15.—Dr. J. L. Myres: Who were the Greeks? (3).

British Institute of Philosophical Studies (at Royal Anthropological Institute), at 5.30.—H. J. Laski: The Idea of a Pluralistic State.

Institution of Electrical Engineers (jointly with the British Section of the French Society of Civil Engineers), at 6.—H. Parodi: The Electrification of the Paris-Orleans Railway.

Institution of Structural Engineers (Yorkshire Branch) (at Great Northern Hotel, Leeds), at 6.30.—Prof. J. Husband: Transverse Bracing of Bridges.

Institute of Chemistry (Edinburgh and East of Scotland Section) (jointly with Society of Chemical Industry) (Edinburgh and East of Scotland Section) (at North British Station Hotel, Edinburgh), at 7.30.—Open Meeting.

Chemical Society, at 8.—J. H. Gardiner: The Ultra-violet Spectrum of the Rare Earths, Neodymium, Praseodymium, Samarium, Europium, Erbium, and Some Others.

Royal Society of Tropical Medicine and Hygiene (at 11 Chandos Street, W.), at 8.15.—Dr. P. A. Buxton: The Depopulation of the New Hebrides and other Melanesian Islands.

London Clinical Society (at London Temperance Hospital), at 8.45.—Sir Arbuthnot Lane: Is Civilisation a Failure?

FRIDAY, February 19.

Geological Society of London, at 3.—Annual General Meeting.

Royal Society of Arts (Indian Section), at 4.30.—Sir Michael F. O'Dwyer: Religions and Races in the Punjab (Sir George Birdwood Memorial Lecture).

Royal College of Surgeons of England, at 5.—Dr. A. Piney: The Importance of Hæmatology in Surgery.

British Institute of Philosophical Studies (at Royal Anthropological Institute), at 5.30.—Prof. T. H. Pear: The Nature of Intelligence and Intelligence Tests.

Institution of Municipal and County Engineers (West Midland District) (at Council House, Birmingham), at 5.30.—H. V. Overfield: Concrete in Modern Road Construction.

Society of Chemical Industry (Liverpool Section) (at University, Liverpool), at 6.—Dr. A. C. Cumming: Cane Sugar Refining.

Institution of Mechanical Engineers (Annual General Meeting), at 6.—E. G. Herbert: The Measurement of Cutting Temperatures.

Royal Photographic Society of Great Britain, at 7.—T. Bell: Address.

Photomicrographic Society (at 4 Fetter Lane), at 7.—Members' Evening.

Junior Institution of Engineers, at 7.30.—S. Reilly: Coal-cutting Machinery.

North-East Coast Institution of Engineers and Shipbuilders (Middlesbrough Branch, Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—P. G. Corin: Electricity applied to the Motor Car.

Royal Institution of Great Britain, at 9.—Hon. J. W. Fortescue: George III. in his Papers.

Society of Chemical Industry (South Wales Section) (at Technical College, Swansea).—E. A. Tyler: Some Notes on Pure Chemicals.

SATURDAY, February 20.

British Psychological Society (Industrial Section) (at National Institute of Industrial Psychology, 329 High Holborn), at 11.30.—Prof. Pear: What is meant by Skill in Industry.

Royal Institution of Great Britain, at 3.—Dr. G. Macdonald: Roman Britain (1).

Gilbert White Fellowship (at 6 Queen Square, W.C.), at 3.—G. Avenell: A Glance at Richard Jefferies (Lecture).

Physiological Society (at King's College).

PUBLIC LECTURES.

SATURDAY, February 13.

Horniman Museum (Forest Hill), at 3.30.—H. N. Milligan: Sea-Shells and their Makers.

MONDAY, February 15.

King's College, at 5.30.—Dr. F. A. P. Aveling: The Human Will (5): Modern Views—Experimental Work.

Dyers' Hall (Dowgate Hill), at 6.—R. Fraser Thomson: Vat Dyes and Some Recent Developments.

TUESDAY, February 16.

King's College, at 5.30.—Miss Hilda D. Oakeley: Philosophy and History (5): The Problem of Truth in History.

Gresham College, at 6.—W. H. Wagstaff: Geometry. (Succeeding Lectures on February 17, 18, 19.)

WEDNESDAY, February 17.

University of Liverpool, at 5.30.—Sir Frederick Mott: Heredity in relation to Mental Diseases and Mental Deficiency (Chadwick Lecture).

University College, at 5.30.—J. Haantjes: The Frisian Country, Language and Literature.

THURSDAY, February 18.

London School of Economics and Political Science, at 5.—Dr. B. Malinowski: The Aims of Social Anthropology.

FRIDAY, February 19.

King's College, at 5.30.—Prof. R. Ruggles Gates: Vegetation on the Amazon. (Succeeding Lecture on February 26.)

SATURDAY, February 20.

Horniman Museum (Forest Hill), at 3.30.—Gordon V. Childe: An[illegible] Crete and the Myths of the Greeks.

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Racial Purification.

THE need for a radical change in the official attitude towards research into the causes of mental disorder has already been advanced in these columns. The problem afforded by the presence among us of a large number of persons suffering from congenital defects of varying severity, though allied and at some points inseparable from the problem of lunacy, has important differences. The hereditary factor is more obvious in cases of congenital mental deficiency than in most of the acquired conditions leading to certification under the Lunacy Acts. In 1923, Dr. Henry Brackenbury, writing in the *Eugenics Review*, acknowledged that "left to itself this sore of society shows no tendency towards cure. On the contrary, it becomes more accentuated generation by generation. Feeble-minded persons are more fecund than the normal; they have a tendency to mate together, and so to produce offspring markedly partaking of the parental characteristics." On January 20, 1926, with other signatories to a letter to the *Times*, the same writer said:

> "It is an undoubted fact that although the majority of cases of mental defect are the result of inheritance, the proportion of cases who are the offspring of actually defective parents is, in relation to the whole, an extremely small one."

It is conceivable that these statements are reconcilable; but while we have at least one analysis by modern statistical methods to fall back upon, it seems only fair to adopt it. Only last autumn, the Galton Laboratory published conclusions based on statistical facts relating to children of British and alien parentage, including very dull and mentally defective subjects:

> "For the practical purposes of prognosis there does not exist in the present material any correlation of the slightest consequence between the intelligence of the child and its physique, its health, its parents' care, or the economic and sanitary conditions of its home. . . . As the result of the investigations published in this paper, and in others from the Galton Laboratory, intelligence as distinct from mere knowledge stands out as a congenital character. Let us admit finally that the mind of man is for the most part a congenital product, and the factors which determine it are racial and familial; we are not dealing with a mutable characteristic capable of being moulded by the doctor, the teacher, the parent or the home environment."[1]

Following upon reports to the Governments of Sweden and New Zealand favouring the sterilisation of mental defectives, and a vigorously worded plea by Mr. Harold Cox in the *Spectator* for this method of racial purification in Great Britain, cogent arguments in favour of the proposal were set forth in the *Times* for January 18 over the signatures of ten distinguished members of the medical profession. Claiming a "wide practical knowledge of mental deficiency" denied to these specialists, four office-bearers of the Central Association for Mental Welfare replied that the preventive effect would be slight and the resultant social evil considerable. Of the ensuing correspondence little can be said, except that it showed the conditions to be more favourable to argumentation about the problem than to the formation of sound opinion.

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[1] "Problem of Alien Immigration," by Karl Pearson and Margaret Moul, *Annals of Eugenics*, vol 1, pt. I. Cambridge: University Press.

One of the duties of local authorities under the Mental Deficiency Act 1913 is "ascertainment." The total number of mental defectives "ascertained" up to the end of 1924 (England and Wales) was 48,778, for whom six local authorities have "realised the urgency of provision [of care] and have acquired estates on which to establish colonies." But ascertainment varies in different districts. In Oxford County Borough it is 4·17 a thousand; in South Shields County Borough it is 0·10 a thousand. Sixty-four local authorities have not yet "ascertained" one in a thousand of their populations, partly from inertia or parsimony or official discouragement, or a knowledge that all available accommodation was full to overflowing. But six local authorities average 3·28 a thousand. If this incidence prevailed for the whole country (and the true average as it affects the fitness of the population is not lower, but far higher), a number comparable with the total of lunatics at present under care would be added to the "ascertained" mental defectives. There appears to be no reason why a segregated mental defective should cost less to keep than a segregated lunatic, and there are at present 19,376 defectives in institutions similar to those provided for lunatics. This much is clear, then, that to pursue an adequate policy of segregation would involve the addition to the nation's incapacity bill of a sum comparable with the present lunacy administration, or about 7,000,000*l.* a year.

Setting aside the unpractical suggestion of the Board of Control that, since "one of the most serious difficulties arises from the fact that patients on licence are naturally apt to form friendships with members of the opposite sex, . . . we advise that whenever a defective who is out on licence appears to be contracting relationships with the opposite sex, the fact should be reported to the Local Authority concerned with a view to their taking such action as they may think is called for . . .,"[2] two proposals remain: (1) Sterilisation, which, in the language of the Board, "one or two Local Authorities and a judge of the High Court have even suggested"; and (2) the restriction of immigration.

The arguments put forward in favour of sterilisation are its simplicity and its efficacy so far as individual propagation is concerned. In the female, it is now customarily performed in the numerous cases where pregnancy is terminated by Cæsarean section owing to the presence of contracted pelvis. As so performed, each Fallopian tube is ligatured twice and the tube divided between the ligatures. In the male, the operation involves no entry into the abdomen and is thus of shorter duration, involving only an incision through the skin along the line of the vas deferens, separation of that tube from the accompanying blood-vessels, and its section, as in the female, between ligatures. On the whole, there is more rather than less to be said in favour of the operation in the female than in the male. There is now an extensive surgical experience of its good results. In the male, obliteration of the vas deferens, where it has occurred accidentally, has led to swelling of the testis, and the after-effects of ligature on both sides at puberty are not well known. But simple modifications of the operation in the male can be devised to obviate retention of the secretion from which alone these results can arise.

Objection to sterilisation is made on several grounds the validity of which in most cases it would be very difficult to prove.

(1) *That it does not obviate the necessity for institutional treatment.* It is clear, from police and other sources, that large numbers of defectives not yet ascertained do need care of one kind or another. The following case is from an area where "ascertainment" was only 0·38 a thousand. A mentally defective girl of 21 years of age. She was found to be suffering from venereal disease and to be pregnant. She is described as an imbecile suffering from partial paralysis to an extent which made it doubtful if she could survive her confinement. A charge was brought against her brother, a boy of seventeen, for having sexual intercourse with his sister. The family consisted of father and mother, said to be rather abnormal and simple, and a brother said to be feeble-minded. The imbecile girl and her feeble-minded brother slept in one bed. The judge said: "It is not for me to decide who is responsible for the terrible state of affairs which exists in your home. . . . Somebody is responsible for it, but I regard you as the victim and not the guilty person."[3] It is doubtful here whether any local authority would have considered segregation necessary for the father and mother; yet sterilisation would have served had it been practised.

Large numbers of cases might receive only relatively brief institutional treatment if sterilised in place of lifelong segregation, which is the *sine qua non* of the segregationists.

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[2] Eleventh Annual Report of the Board of Control, p. 79. (H.M. Stationery Office.)

[3] Eleventh Annual Report of the Board of Control.

(2) *That many parents of defectives are not themselves defective.* From considerable personal acquaintance with mental defectives and their relatives, we are most suspicious of all evidence which appears to lend any support to this contention, notwithstanding the opinion of Prof. Jennings (of Johns Hopkins University) that "whatever eugenic measures are attempted, so long as biparental inheritance is kept up, the variety, the surprises, the perplexities, the melodrama that now present themselves among the fruits of the human vine will continue." It is a subject in which all manner of circumstances conspire to mislead the inquirer. While congenital malformations involving deficiency arise frequently and apparently sporadically, they give rise in most cases to extreme forms of mental defect and are almost wholly incompatible with social (or anti-social) behaviour. Such cases do not constitute a social problem and must not be confused with the degenerate tendencies which do.

(3) *That sterilisation might lead to a false sense of security and involve the intensification of other evils.* The irony of this argument lies chiefly in its source—those who claim "practical" knowledge of mental deficiency. It supposes an *absence* of the normal powers of self-control, prevision and obedience to social convention, and pretends that licence would result from the removal of the need for what is absent. Or it supposes that advantage would be taken by normal individuals of the sterilisation of imbeciles! The argument is scarcely worthy of serious consideration.

(4) *Popular opposition.* Probably, if the truth were known, the general public would go much further than any Government is likely to ask it to go for years to come.

There remains the alien contribution to racial deterioration. There appears to be no reason why we should not at least adopt the sound advice of Prof. Karl Pearson and his collaborator, founded on a basis of scientific inquiry foreign to official control: "Let us set a standard for immigrants, say 25 per cent higher than the mental and physical averages of the native population—and in the present state of our medical, physical and psychological anthropometry this is not an idle dream—and let us allow none to enter who fails to reach this standard."

There are many points upon which biologists may and do disagree with Prof. Karl Pearson, but it would be difficult to think of any one more pre-eminently fitted to direct such an investigation as would bring order out of the chaos of official facts and fancies and equip the nation with sound principles for action. Of clear knowledge at present we have next to none.

Fruit and Fruit Growing.

(1) *A Handbook of Hardy Fruits more commonly grown in Great Britain: Stone and Bush Fruits, Nuts, etc.* By Edward A. Bunyard. Pp. 258. (London: John Murray, 1925.) 10*s.* 6*d.* net.

(2) *Systematic Pomology.* By U. P. Hedrick. (The Rural Science Series.) Pp. xviii+488+24 plates. (New York: The Macmillan Co., 1925.) 17*s.* net.

(3) *The Lorette System of Pruning.* By Prof. Louis Lorette. Translated by W. R. Dykes. Pp. xliv+166. (London: Martin Hopkinson and Co., Ltd., 1925.) 7*s.* 6*d.* net.

(1) THIS book is the second and concluding volume of a work designed by the author to fill the place formerly occupied by Dr. Hogg's "Fruit Manual." The latter has been generally accepted by pomologists as the standard work of reference on varieties of fruit grown in Great Britain since it first appeared some fifty years ago, but nearly forty years have elapsed since the issue of the last edition. During that interval many of the most popular and widely grown present-day varieties have been raised and introduced and there has been, accordingly, an obvious need for either an up-to-date edition of the "Fruit Manual" or a new work of a similar character. For the preparation of such a work there is probably no British pomologist better qualified to undertake the task than Mr. Edward Bunyard.

The work lays no claim to completeness, the author stating in his preface to the first volume that he considers it unwise to include descriptions of varieties other than those which are more generally cultivated. Some limitation of the sort is necessary in a handbook of relatively modest size, for the number of varieties of the common hardy fruits grown in Great Britain is far larger than generally supposed. The element of selection of material thus introduced inevitably exposes the work to criticism as to the right of place of many of the sorts described. In the volume under review, which treats of all the hardy fruits except the apple and pear, a noteworthy omission is the Warwickshire Drooper plum, a variety of frequent occurrence in the important Evesham plum-growing area, while other sorts rarely met with outside a few nurseries and private gardens are included. Among strawberries, there is no reference to Laxton and Monarch, two kinds of some vogue in the earlier years of the present century, or to Ruskin, a leading Scotch variety.

Notwithstanding omissions of this kind, the book is of real assistance to the systematic pomologist, for the varietal descriptions are generally accurate, concise, and mostly the result of first-hand observation, which has enabled doubtful identities to be cleared up. In the case of cherries and red currants particularly the work gains added value and interest from the author's own investigations in the systematics of those fruits.

(2) Prof. Hedrick's book on systematic pomology serves in many respects a similar purpose for the student of fruit culture in the United States and Canada. The more important and interesting varieties of hardy fruits grown in North America are described briefly; their history, when known, stated; and the author's conclusions on their merits generally given. Included in the list of sorts described are several kinds of European origin, and it is interesting to compare the observations on these growing under North American conditions with those on the same varieties under English conditions recorded in Bunyard's handbook. A similar remark applies to the varieties of American origin included in both works. It is suggestive of the different influence of American and English conditions to find the Ribston Pippin apple, now generally discarded in Great Britain on account of its susceptibility to canker, described by Hedrick as a variety producing hardy, vigorous, and long-lived trees; at the same time, Cox's Orange Pippin, the leading English dessert apple, also like Ribston Pippin a delicate sort, has not been considered of sufficient importance in American pomology to merit inclusion.

As the title indicates, the scope of this work is wider than that of the preceding. Systematic pomology, as defined by the author, is the study of the kinds of fruits and their relationships. He has, accordingly, in a series of introductory chapters, given a brief general description of the structure and arrangements of the various organs to enable the student to grasp the principles upon which the classification of varieties of the respective kinds of fruits is based. The volume is intended primarily for classroom work, and largely comprised of abbreviated material taken from the author's "Cyclopedia of Hardy Fruits" and the elaborate monographs on various fruits which have been prepared by him and published by the State of New York. It fills a distinct gap in pomological literature and, although concerned with American material, should prove of use as well as interest to pomologists generally.

(3) The third volume of the group is a translation of the fourth French edition of Prof. Lorette's book on his methods of pruning fruit trees, by the late Mr. W. R. Dykes, secretary of the Royal Horticultural Society.

The volume is mainly a description of a system of pruning evolved by the author after many years of practical trials at the School of Agriculture at Wagnonville, near Douai. The essence of the system is that the normal practice of pruning in winter is entirely discarded in favour of a series of summer treatments applied chiefly in June and July. By this means it is claimed that the energies of the tree can be concentrated on fruit production, the formation of unnecessary shoot growth being prevented. While at first sight the drastic removal of young leafy shoots in the height of the summer may appear to reduce rather than improve the tree's chance of accumulating adequate organic reserve food materials necessary for blossom and fruit formation, it is asserted that the result is the production of a large leaf area so situated that it promotes the development of fruit buds instead of unwanted extensive shoots. Suitable manuring is at the same time regarded as essential to maintain vitality.

The author lays stress on the individual details of his system, which render it fundamentally distinct from the older, generally practised form of summer pruning. Special attention is given to the form of the tree and the production of an evenly balanced branch system, in which the forced growth of "stipulary" buds plays an important part. The spacing of individual branches is another feature of particular concern. The directions for treatment given, which refer chiefly to the pear, are those which have yielded best results at Wagnonville, but minor modifications are considered necessary according to soil and climate. This point will be appreciated by those who have tried the method in some of the rainier districts in Great Britain.

Some measure of support for the system on scientific grounds is forthcoming from recent research on pomological physiology. In the original French the exact meaning of the author was not clear in places. The translator has allowed himself some latitude with advantage, and does well to direct attention to the difficulties arising from the want of an accepted nomenclature for the various types of lateral shoots of fruit trees.

The merits of the system have already been much debated, but there can be no doubt of the service which the author has rendered to scientific pomology in securing attention to the fundamental principles underlying all methods of pruning.

Biological Problems.

La concentration en ions hydrogène de l'eau de mer—le pH: méthodes de mesure; importance océanographique, géologique, biologique. Par R. Legendre. (Les problèmes biologiques.) Pp. vii + 291. (Paris: Les Presses universitaires de France, 1925.) 30 francs.

UNDER the above general title a series of monographs is being issued by the University Press, Paris. Of these the volume under review is the third. Dr. R. Legendre, Director of the Laboratory of Comparative Physiology in the École des Hautes Études, Paris, is indeed to be congratulated upon the production of his monograph. It is well printed, lucid, contains a vast amount of detail skilfully woven into a consideration of a surprisingly large number of physiological and geological themes, and is, in short, interesting from cover to cover. It is to be hoped that it will have many English readers, for those in search of problems for research are given a wide field from which to select if they read the book.

Somewhat more than one-third of the book is devoted to a description of the methods of measuring hydrogen ion concentration; details necessary for practical work are given as well as a theoretical introduction to the subject—this, moreover, is written especially for the weak brother and is developed from a few fundamental principles. Chapters 2-4 deal with the alkalinity of sea-water, its changes with depth, season, and latitude, its relation to the precipitation of calcium carbonate and to the nature of oceanic deposits. This portion is of especial interest to the hydrographer and the geologist.

The remaining third of the book is occupied by a discussion of the biological problems which are connected with the hydrogen ion concentration or *p*H value of the sea. They include researches on respiration, photosynthesis, the mineral constituents of marine plants and animals, seasonal changes in the plankton, tropisms, composition of intracellular liquids, permeability, isoelectric points, ciliary movements, and the maturation, fertilisation, parthenogenesis, and division of the egg. There is also a brief, but useful, appendix on methods of maintaining sea-water in a condition fit for marine animals and upon artificial sea-water. A notable feature of the book is the large number of references given both to early and to the most recent work, including many researches carried out by Dr. Legendre himself, a fact which ensures that the volume is critical throughout and no mere compilation.

The reviewer would, however, point out that, in common with other distinguished physiologists, the author writes of the "tension" exerted by aqueous vapour and by carbon dioxide, instead of using the correct term pressure. As an example of the confusion due to the use of the term "tension" we may consider the Clark hydrogen electrode vessel, containing hydrogen gas—which exerts a pressure—also water vapour and carbon dioxide exerting "tensions" The total pressure is found by adding the pressure to the two "tensions."

A list of errata is issued with the book. In addition the following have been noted: P. 112, in ll. 1, 3, and 4 B means any monovalent base, but in l. 2 it stands for the element boron; p. 112, l. 17, for "mai" read "mars"; p. 147, l. 9 from bottom, for "mai" read "octobre."

It may also be remarked that C. B. Lipman's recent paper (Publ. No. 340, Carnegie Inst.) has shown that the views formerly put forward, concerning the precipitation of calcium carbonate in tropical waters being due to denitrifying bacteria, are incorrect. Winkler's method of estimating oxygen is given on p. 189 as involving titration with sodium sulphite, but thiosulphate is more generally used. The statement on p. 275 that artificial sea-water "ne permet jamais aucune culture" appears to be rather too vigorous an interpretation of Allen's results, and those of Drummond and Peach have, moreover, to be considered.

In conclusion, it may be said that the book augurs well for the success of the series, and is heartily recommended.

W. R. G. A.

Experimental Physics.

(1) *A Laboratory Manual of Experiments in Physics.* By Prof. Leonard Rose Ingersoll. Pp. ix+220. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 10*s.* net.

(2) *Heat: an Elementary Text-Book.* By Dr. Ivor B. Hart. (Bell's Natural Science Series) Pp. vii+226. (London: G. Bell and Sons, Ltd., 1925.) 3*s.* 6*d.*

(3) *Practical Physics: for the Use of Students of Natural Philosophy.* Part 2. (By the Staff of the Department.) Pp. 71. (Melbourne: Melbourne University Press, 1925.) n.p.

(4) *Individual Work in Science.* By Herbert McKay. Part 1. Pp. vii+97. Part 2. Pp. vii+97. Part 3. Pp. vii+97. 1*s.* 3*d.* each. Part 4: Teacher's Book. Pp. vii+95. 3*s.* 6*d.* (London: University of London Press, Ltd., 1925.)

(5) *An Introduction to Physical Science.* By Dr. Ivor B. Hart. Pp. xii+306. (Oxford: Clarendon Press; London: Oxford University Press, 1925.) 4*s.* net.

These books under notice are mostly concerned with instruction in practical physics, although their standard varies from that of an honours university course to an introductory school course.

(1) Prof. Ingersoll's laboratory manual of experiments in physics embodies the work of the elementary class in the University of Wisconsin. The book is prefaced by a useful introduction dealing with curve plotting, averages, errors, etc., and then proceeds to simple exercises with measuring instruments. There is little that requires comment in the selection of experiments, seventy-six in all, except that the section devoted to light, which contains only nine experiments, seems rather inadequate.

(2) The author of "A Student's Heat" has here

reproduced the elementary parts of that text-book with the view of meeting the requirements of matriculation students. The book follows orthodox lines and is well furnished with examples of a practical character. The historical aspect of the subject is not overlooked, and although the book is not intended to assist the student in carrying out laboratory exercises, the necessary fundamental experiments are well described and illustrated.

(3) The third book on our list is a series of about fifty experiments forming part of the physics course at the University of Melbourne. It ranges from the synthesis of periodic curves to the measurement of alpha-rays. The experiments are mostly of standard type, although some involve the use of apparatus (Prestwich fluid gauge, slip gauges, Michell viscometer) not commonly found in physical laboratories. It is a useful compilation.

In (4) we pass to the other end of the scale, the three small books included in this set being designed to meet the need of school teachers for small inexpensive books from which beginners can work with a minimum of supervision. Each book covers a one-year course in elementary physics, with forty-eight lessons distributed over the various branches of the subject. The course is well planned and carefully thought out, the experiments are concisely but sufficiently described, and most of the apparatus required is either home-made or easily procured.

An additional volume for the guidance of the teacher contains lists of the apparatus required, and gives suggestions for the distribution of the experiments in the class. The standard reached, even in the third-year course, is very elementary, and with the exception of the sections on measurement and mechanics, is almost wholly qualitative, but it provides a good introduction to the subject.

(5) The volume which appears at the end of our list is an introduction to physical science intended to steer a middle course between the Scylla of excessive concentration on accurate measurement and the Charybdis of snappy description of everyday physics divorced from the discipline of practical work. The author has certainly succeeded in producing a very attractive volume. The subjects are treated in an interesting and practical way, the illustrations are numerous and good, while the paper and type add considerably to the pleasure of using the book. The main defect is a lack of proportion in the treatment of the various branches of the subject. Magnetism, static electricity, and current electricity are dismissed in 28 pages, containing only two practical exercises, both in magnetism. On the other hand, the excellent section on hydrostatics extends to 82 pages and contains more than twenty practical exercises.

Our Bookshelf.

Port Development. By Dr. Roy S. MacElwee. Pp. xv+456. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 25*s*. net.

THE subject of port development may be regarded from two points of view: (1) physical, or constructional, and (2) commercial. It is from the latter viewpoint that Dr. MacElwee has written the work under notice, and in it he considers the various factors which make for the prosperity of a port, serve to foster its trade and to extend its influence. The Americans have a phrase which expresses their idea of treating the port itself as a negotiable instrument: they speak of "selling a port," meaning the disposal of its facilities to commercial and shipping customers. As Dr. MacElwee truly remarks, "Terminal facilities alone, important as they are, will not make a port a successful commercial gateway." It is necessary to impress the trading community with the advantages to be gained by making use of them, and, in this connexion, propaganda work, and "solicitation" (Anglicé, canvassing) are of the greatest importance.

Dr. MacElwee is already well known in port circles on both sides of the Atlantic as the author of several works including "Ports and Terminal Facilities," the success of which has led him to amplify his treatment of the subject. In the present volume he deals with that section which comprises government administration, traffic and solicitation. The field admits of a wide purview and the book consists of four parts. Part I. treats of port development as a matter for serious consideration, and its value, nationally and locally. Part II. institutes a comparison between various typical ports of the world, with an analysis of their attractions to shipping. Part III. deals more particularly with details of port competition: balanced cargoes, tonnage markets, rail and water rates, etc., together with the costs and services at the respective terminals. Part IV. is devoted to the subject of free ports, that is, port areas which are exempt from the imposition of duties on goods landed for re-export.

As Commissioner of a thriving American port, with a wide personal experience extending to ports in the old world as well as the new, Dr. MacElwee writes with a thorough knowledge of his subject. He has collected a large amount of information from a number of sources, and his book will therefore prove a valuable work of reference.

B. C.

The Scent of Flowers and Leaves: its Purpose and Relation to Man. By F. A. Hampton. Pp. vii+135. (London: Dulau and Co., Ltd., 1925.) 6*s*. net.

THIS book is in no sense a compilation, but a valuable contribution to the small literature of odour. The author offers a sound, but non-technical, review of theories of odour, and his classification of flower scents appears to be the best yet made. It is a revision of the suggestions of Kerner von Marilaun, bringing them up-to-date. For this, the author's qualifications are unique, as he successfully combines data from many fields in which he has experience. Previous classifications of odours have been incompletely documented by sponsors experienced in one or two branches of science, and, while much remains to be done to systematise our knowledge of smell, the present classification is very suggestive. Much space is devoted to a discussion of the origin and development of scent, its function in the plant and elsewhere, and to our appreciation of it. The author's theory of human reaction to scents will be more acceptable than the crude and somewhat malodorous treatment usually accorded by the psychologist to the subject.

Garden lovers in the study, especially those planning a garden, will be greatly indebted to Dr. Hampton for the wealth of information on the history of scented plants and the arrangement of a scented garden *Rosa gallica* (the Rose of Provins) is mentioned, but no connected history of this early variety is given. Printers' errors appear to be absent. The repeated spelling "benzine" and the use of "benzoloid" are unfortunate; "stereoptene" should be "stearoptene," and a much fuller index would be valuable. The statement that citral is the scent substance of citronella requires qualification.

The book has a pleasant literary style, and possesses personality. On account of the many interests associated with floral perfume, "Flower Scent" is certain to make a wide appeal, and needs only to be read to be enjoyed.

HUGH NICOL.

Macrophotographie et microphotographie. Par F. Monpillard. (Encyclopédie scientifique: Bibliothèque de photographie.) Pp. xxxi+671. (Paris: Gaston Doin et Cie, 1925.) 25 francs.

THE two branches of the subject are not sharply distinguished, but, speaking generally, macrophotography concerns objects that are large enough to be seen, with at least some detail, by the naked eye, and need only a low magnification, if any, so that they are conveniently photographed by a lens of short focal length attached directly to the camera. Examples given by the author are a group of mounted butterflies and physiological dissections and preparations. Microphotography is the photography of smaller objects with higher magnifications, such that the use of a microscope stand is very desirable if not necessary. Many details are common to both methods of work, so that there is a distinct advantage in treating them together, especially as macrophotography is too often neglected in present-day text-books as belonging neither to ordinary photography nor (as we prefer to call it) photomicrography.

The author includes the use of polarised light, microspectrography, metallography, instantaneous microphotography and microcinematography, photography by means of ultra-violet light, stereoscopic work, microradiography, and stereoradiography. So many subjects obviously cannot be treated at great length in the space available, but the salient points of modern methods are given, and also a good deal of historical matter. It would be advantageous if the illustrations were of better quality and rather more numerous, and we may add that Mr. W. Thorp's method of making grating replicas was not by pressing with an hydraulic press thin celluloid upon an original Rowland grating, as is stated, but by pouring a solution of celluloid upon the original, and then stripping and mounting the resulting film. The volume should certainly be welcomed by scientific workers.

The Daubeny Laboratory Register, 1916–1923: with Notes on Scientific Researches carried out by Members of Magdalen College, Oxford. By R. T. Gunther. Vol. 3. Pp. vii+297-532. (Oxford: The Laboratory, Magdalen College, 1924.) 10*s.* 6*d.*

TWENTY years ago, Mr. Gunther published the first volume on the origin and history of Daubeny's principal benefactions to Magdalen College, Oxford, and in 1915 this was followed by a second volume. He now adds a third volume on work in the Daubeny laboratory from 1916 to 1923, and expresses regret that it is no longer possible to use Daubeny's building for scientific research or the housing of his collection. Changed conditions in the University seem to have been regarded as justifying the closing of the laboratory in 1923.

Mr. Gunther refers to his own researches in the volcanic region of Naples, which were directly stimulated by Daubeny's work and the collections he left to the College. He also gives some account of the recent discovery of Pleistocene mammalian remains in the College grounds, and publishes photographs of some fossil crocodilian vertebræ from the Kimmeridge Clay of Shotover, which appear to be unique in showing stains of the adjacent blood-vessels.

In addition to the record, the volume includes notes on some of the early naturalists associated with Magdalen College, and on others who have undertaken scientific research there. It also incorporates much matter of historical interest to the College, which Mr. Gunther has recovered from the archives while pursuing his researches on early science at Oxford.

The Dynamo: its Theory, Design, and Manufacture. By C. C. Hawkins. Sixth edition, revised throughout and largely rewritten. Vol. 3: *Alternators.* Pp. xviii+572. (London: Sir Isaac Pitman and Sons, Ltd., 1925.) 30*s.* net.

IN this volume the author discusses the design and working of the generators which produce alternating current. So many books and papers have recently been published on the subject that he finds it necessary only to give a rapid résumé of some modern developments. He confines himself to the more practical side of his subject, and the dynamo designer can at once compare his own formulæ with those given by the author. In 1909 Sir Thomas Lyle gave his theory of the alternating current generator to the Physical Society of London. Judging by results, however, it has proved a little too difficult for the practical designer and it is not mentioned by the author. To the student, however, it would prove interesting and instructive. The chapters on the turbo-alternator and the parallel running of alternators have been carefully written and should prove helpful to the engineer. The author, when discussing armature reaction, adopts and strongly advocates the two-reaction method of A. Blondel. This phenomenon is barely mentioned in the older books. For a full discussion of it a theory similar to Lyle's would have to be devised. We can recommend this volume to dynamo designers.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Spinning Electrons and the Structure of Spectra.

So far as we know, the idea of a quantised spinning of the electron was put forward for the first time by A. K. Compton (*Journ. Frankl. Inst*, Aug. 1921, p. 145), who pointed out the possible bearing of this idea on the origin of the natural unit of magnetism. Without being aware of Compton's suggestion, we have directed attention in a recent note (*Naturwissenschaften*, Nov. 20, 1925) to the possibility of applying the spinning electron to interpret a number of features of the quantum theory of the Zeeman effect, which were brought to light by the work especially of van Lohuizen, Sommerfeld, Landé and Pauli, and also of the analysis of complex spectra in general. In this letter we shall try to show how our hypothesis enables us to overcome certain fundamental difficulties which have hitherto hindered the interpretation of the results arrived at by those authors.

To start with, we shall consider the effect of the spin on the manifold of stationary states which corresponds to motion of an electron round a nucleus. On account of its magnetic moment, the electron will be acted on by a couple just as if it were placed at rest in a magnetic field of magnitude equal to the vector product of the nuclear electric field and the velocity of the electron relative to the nucleus divided by the velocity of light. This couple will cause a slow precession of the spin axis, the conservation of the angular momentum of the atom being ensured by a compensating precession of the orbital plane of the electron. This complexity of the motion requires that, corresponding to each stationary state of an imaginary atom, in which the electron has no spin, there shall in general exist a set of states which differ in the orientation of the spin axis relative to the orbital plane, the other characteristics of the motion remaining unchanged. If the spin corresponds to a one-quantum rotation there will be in general two such states. Further, the energy difference of these states will, as a simple calculation shows, be proportional to the fourth power of the nuclear charge. It will also depend on the quantum numbers which define the state of motion of the non-spinning electron in a way very similar to the energy differences connected with the rotation of the orbit in its own plane arising from the relativity variation of the electronic mass. We are indebted to Dr. Heisenberg for a letter containing some calculations on the quantitative side of the problem.

This result suggests an essential modification of the explanation hitherto given of the fine structure of the hydrogen-like spectra. As an illustration we may consider the energy levels corresponding to electronic orbits for which the principal quantum number is equal to three. The scheme on the left side of the accompanying figure (Fig. 1) corresponds to the results to be expected from Sommerfeld's theory. The so-called azimuthal quantum number k is defined by the quantity of moment of momentum of the electron about the nucleus, $kh/2\pi$, where $k = 1, 2, 3$. According to the new theory, depicted in the scheme[1] on the right, this moment of momentum is given by $Kh/2\pi$, where $K = \frac{1}{2}, \frac{3}{2}, \frac{5}{2}$. The total angular momentum of the atom is $Jh/2\pi$, where $J = 1, 2, 3$. The symbols K and J correspond to those used by Landé in his classification of the Zeeman effects of the optical multiplets. The letters S, P, D also relate to the analogy with the structure of optical spectra which we consider below. The dotted lines represent the position of the energy levels to be expected in the absence of the spin of the electron. As the arrows indicate, this spin now splits each level into two, with the exception of the level $K = \frac{1}{2}$, which is only displaced.

In order to account for the experimental facts, the resulting levels must fall in just the same places as the levels given by the older theory. Nevertheless, the two schemes differ fundamentally. In particular, the new theory explains at once the occurrence of certain components in the fine structure of the hydrogen spectrum and of the helium spark spectrum which according to the old scheme would correspond to transitions where K remains unchanged. Unless these transitions could be ascribed to the action of electric forces in the discharge which would perturb the electronic motion, their occurrence would be in disagreement with the correspondence principle, which only allows transitions in which the azimuthal quantum number changes by one unit. In the new scheme we see that, in the transitions in question, K will actually change by one unit and only J will remain unchanged. Their occurrence is, therefore, quite in conformity with the correspondence principle.

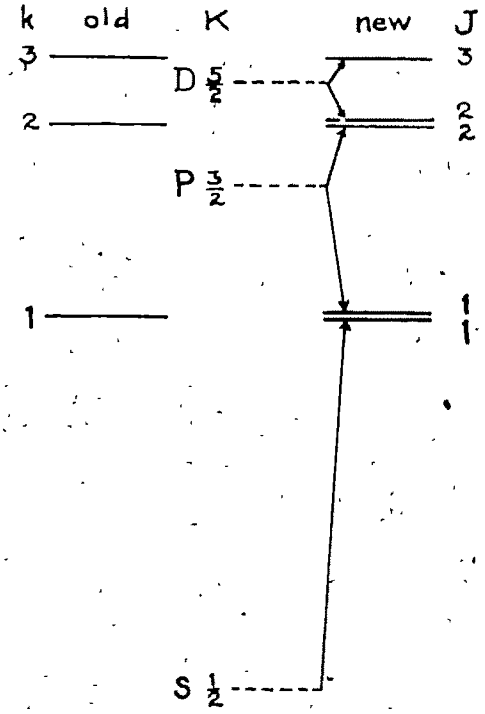

FIG. 1.

The modification proposed is specially important for explaining the structure of X-ray spectra. These spectra differ from the hydrogen-like spectra by the appearance of the so-called "screening" doublets, which are ascribed to the interaction of the electrons within the atom, effective mainly through reducing the effect of the nuclear attraction. In our view, these screening doublets correspond to pairs of levels which have the same angular momentum J but different azimuthal quantum numbers K. Consequently, the orbits will penetrate to different distances from the nucleus, so that the screening of the nuclear charge by the other electrons in the atom will have different effects. This screening effect will, however, be the same for a pair of levels which have the same K but different J's and correspond to the same orbital shape. Such pairs of levels were, on the older theory, labelled with values of k differing by one unit, and it was quite impossible to understand why these so-called "relativity" doublets should appear separately from the screening doublets. On our view, the doublets in question may more properly be termed "spin" doublets, since the sole reason for their appearance is the difference in orientation of the spin axis relative to the orbital plane. It should be emphasised that our interpretation is in complete accordance with the correspondence principle as regards the rules of combination of X-ray levels.

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[1] Quite independently of the ideas discussed here, a scheme of levels corresponding to this figure has been previously proposed by the writers (*Physica*, 5, 266, 1925), on the ground of the formal analogy between spectral structures. From similar formal considerations, this scheme has recently also been arrived at by J. C. Slater (*Proc. Washington Acad.*, December 1925).

The assumption of the spinning electron leads to a new insight into the remarkable analogy between the multiplet structure of the optical spectra and the structure of X-ray spectra, which was emphasised especially by Landé and Millikan. While the attempt to refer this analogy to a relativity effect common to all the structures was most unsatisfactory, it obtains an immediate explanation on the hypothesis of the spin electron. If, for example, we consider the spectra of the alkaline type, we are led to recognise in the well-known doublets regular spin doublets of the character described above. In fact, this enables us to explain the dependence of the doublet width on the effective nuclear charge and the quantum numbers describing the orbit, as well as the rules of combination.

The simplicity of the alkaline spectra is due to the fact that the atom consists of an electron revolving round an atomic residue which contains only completed electronic groups, which are magnetically inert. When we pass to atoms in which several electrons revolve round a residue of this kind we meet with new features, since we have to take account of other directing influences on the spin axis of each electron besides the couple due to its own motion in the electric field. Not only does this enable us to account for the appearance of multiplets of higher complexity, but it also seems to throw light on the so-called "branching" of spectra, which usually accompanies the adding of a further electron to the atom, and for which hitherto no satisfactory explanation has been given. In fact, it seems that the introduction of the concept of the spinning electron makes it possible throughout to maintain the principle of the successive building-up of atoms utilised by Bohr in his general discussion of the relations between spectra and the natural system of the elements. Above all, it may be possible to account for the important results arrived at by Pauli, without having to assume an unmechanical "duality" in the binding of the electrons.

So far we have not mentioned the Zeeman effect, although the introduction of the spinning electron was primarily suggested by the analysis of the anomalous Zeeman effects shown by the components of multiplet structures. From the point of view of the correspondence principle, this effect shows that the influence of a magnetic field on the motion of the atom differs considerably from that to be expected if the electron had no spin. In fact, from the well-known theorem of Larmor we would expect the effect on any spectral line to be of the simple Lorentz type, quite independently of the character of the multiplet structure. Therefore the appearance of the anomalous Zeeman effects has hitherto presented very grave difficulties. However, these difficulties disappear at once when, as assumed, the electron has a spin and the ratio between magnetic moment and angular momentum of this spin is different from that corresponding to the revolution of the electron in an orbit large compared with its own size. On this assumption the spin axis of an electron not affected by other forces would precess with a frequency different from the Larmor rotation. It is easily shown that the resultant motion of the atom for magnetic fields of small intensity will be of just the type revealed by Landé's analysis. If the field is so strong that its influence on the precession of the spin axis is comparable with that due to the orbital motion in the atom, this motion will be changed in a way which directly explains the gradual transformation of the multiplet structure for increasing fields known as the Paschen-Back effect.

It seems possible on these lines to develop a quantitative theory of the Zeeman effect, if it is assumed that the ratio between magnetic moment and angular momentum due to the spin is twice the ratio corresponding to an orbital revolution. At present, however, it seems difficult to reconcile this assumption with a quantitative analysis of our explanation of the fine structure of levels. In fact it leads, in a preliminary calculation, to widths of the spin doublets just twice as large as those required by observation. It must be remembered, however, that we are here dealing with problems which for their final solution require a closer study of quantum mechanics and perhaps also of questions concerning the structure of the electron.

In conclusion, we wish to acknowledge our indebtedness to Prof. Niels Bohr for an enlightening discussion, and for criticisms which helped us distinguish between the essential points and the more technical details of the new interpretation.

G. E. UHLENBECK.
S. GOUDSMIT.
Instituut voor Theoretische Natuurkunde,
Leyden, December 1925.

HAVING had the opportunity of reading this interesting letter by Mr. Goudsmit and Mr. Uhlenbeck, I am glad to add a few words which may be regarded as an addition to my article on atomic theory and mechanics, which was published as a supplement to NATURE of December 5, 1925. As stated there, the attempts which have been made to account for the properties of the elements by applying the quantum theory to the nuclear atom have met with serious difficulties in the finer structure of spectra and the related problems. In my article expression was given to the view that these difficulties were inherently connected with the limited possibility of representing the stationary states of the atom by a mechanical model. The situation seems, however, to be somewhat altered by the introduction of the hypothesis of the spinning electron which, in spite of the incompleteness of the conclusions that can be derived from models, promises to be a very welcome supplement to our ideas of atomic structure. In fact, as Mr. Goudsmit and Mr. Uhlenbeck have described in their letter, this hypothesis throws new light on many of the difficulties which have puzzled the workers in this field during the last few years. Indeed, it opens up a very hopeful prospect of our being able to account more extensively for the properties of elements by means of mechanical models, at least in the qualitative way characteristic of applications of the correspondence principle. This possibility must be the more welcomed at the present time, when the prospect is held out of a quantitative treatment of atomic problems by the new quantum mechanics initiated by the work of Heisenberg, which aims at a precise formulation of the correspondence between classical mechanics and the quantum theory.

N. BOHR.
Copenhagen, January 1926.

Carnot's Cycle and Efficiency of Heat Engines.

In NATURE of August 29, 1925, there was published on p. 326 an extract of a paper read by Dr. Haldane before the Institution of Mining Engineers at Cardiff on June 16, in which he advances a somewhat unusual view as regards the efficiency of the Carnot cycle.

A defence of the orthodox view was made by Prof. Porter on October 3, p. 497, and by Mr. Butler on October 24, p. 608. Prof. Porter demonstrates quite clearly that for any given temperatures a higher efficiency is always obtained with the Carnot cycle than with that proposed by Dr. Haldane.

In reply to his critics Dr. Haldane has since published a further paper in which he maintains his original view. Since, however, a correct appreciation of the thermo-dynamics of the cycle of a heat engine underlies all engineering practice, a matter so fundamental should not permit of any misunderstanding. It is, therefore, desirable to determine at what point Dr. Haldane diverges from the orthodox treatment.

The efficiency of a heat engine is the ratio of the heat converted into work to that which is received by the engine from the source of the heat. The Carnot cycle consists of the following processes:

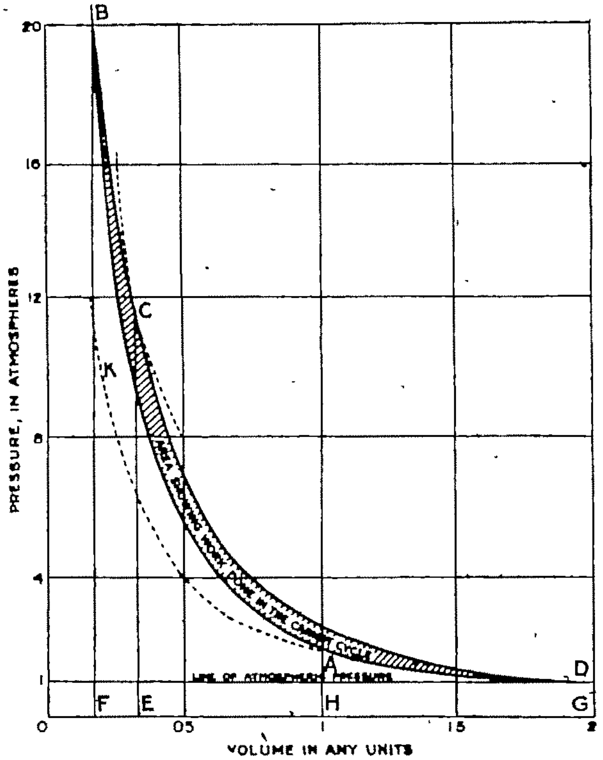

FIG. 1.—Dr. Haldane's diagram of Carnot cycle with lower absolute temperature 50 per cent. below upper.

Isothermal expansion with work done by the working fluid on the piston during the reception of heat.

Adiabatic expansion with work done by the working fluid on the piston at the expense of the intrinsic energy of the fluid.

Isothermal compression during which work is done by the piston on the working fluid whilst heat is rejected; and adiabatic compression during which energy is restored to the fluid equal to the work done on it by the piston.

It is only during one of these processes, namely, isothermal expansion, that the working fluid receives heat from the outside source.

Now Dr. Haldane in his second paper considers the case of a Carnot cycle for a perfect gas with the absolute temperature of the source double the absolute temperature at which heat is rejected, and the efficiency therefore, by the usual theory, 50 per cent. He reasons as follows:

"The work W done by the air during expansion is represented by the area BCDGF [see Fig. 1 reproduced from Dr. Haldane's second paper]. The work w done on the air during compression is represented by the somewhat smaller area BADGF. The net work $W - w$ done in the cycle is represented by ABCD, hence the efficiency is according to the contention of my paper $(W - w)/W$, and we can see at once that this is very small and far below 50 per cent."

It is clear, therefore, that Dr. Haldane is led to a wrong determination of the efficiency of the cycle, because he adopts an unusual valuation for the amount of heat received, which he takes to be equal in equivalent units to the total work done during expansion, whereas the heat actually received by the working fluid from the source of heat is only that which is absorbed during isothermal expansion, and in the case of a perfect gas is equal to the work done during that process only. It is not surprising, therefore, that he arrives at too low a value for the efficiency of the Carnot cycle.

From a careful perusal of Dr. Haldane's papers, he appears to contend that the heat received by the working fluid during the process of isothermal expansion is not the total amount received. There must, he argues, be added the heat equivalent of the work done against the fluid during adiabatic compression in order to arrive at the total heat which the fluid receives.

Since, however, this work of compression is deducted from the work done during expansion in order to arrive at the net work of the engine, it will be seen that it is obtained from the engine itself, and should not be charged against what the engine receives from the source of heat. By so charging it, Dr. Haldane really debits the cycle with this part of the negative work twice over; he uses it to reduce the net work done as in the orthodox treatment, and he also uses it to increase his value for the total heat received.

STANLEY S. COOK.
The Parsons Marine Steam Turbine Co., Ltd.,
Turbinia Works, Wallsend-on-Tyne,
January 25.

REFERRING to Dr. Haldane's recent paper on "The Maximum Efficiency of Heat Engines," an abstract of which appeared in NATURE of August 29, 1925, it was difficult when reading the paper to grasp the precise basis upon which the majority of Dr. Haldane's reasoning rests. Some light was thrown on this obscurity, however, by Dr. Haldane's reply to the discussion of his paper. On p. 409, vol. 69, Part 5, of the *Transactions of the Institution of Mining Engineers*, he says:

"When, however, the amount of heat (supplied) is the same in the two cases, the Carnot cycle is always relatively inefficient as compared with the corresponding Haldane cycle. . . . Prof. Porter quite rightly points out that in the Haldane cycle, the difference between T_1 and T_2 is greater than in the Carnot cycle."

It thus appears that Dr. Haldane maintains that the efficiency of different heat engine cycles must be compared on a basis of a given amount of heat supplied, and not, as in the orthodox view, on a basis of temperature range.

That a temperature range is essential to the working of a heat engine is a matter of common observation, with which, presumably, even Dr. Haldane agrees Carnot summed up the situation in the converse statement "Wherever there exists a difference of temperature, motive power can be produced." Carnot went on to show that the efficiency of a thermo-dynamically reversible cycle is proportional to the temperature range solely, and that for a given temperature range no heat engine cycle can possibly be more efficient than a thermo-dynamically reversible one.

Now Dr. Haldane's cycle is not thermo-dynamically reversible Carnot's cycle is thermo-dynamically reversible; therefore, Dr Haldane's cycle cannot possibly be more efficient than Carnot's cycle. Further, since, by definition, efficiency $= \frac{\text{work done}}{\text{heat supplied}}$, it is evident that efficiency is a ratio independent of the actual magnitudes of the quantities involved, so that to base a comparison of efficiencies on a given quantity of heat is valueless

In his second published reply to his critics, Dr. Haldane abandons this point of view and attacks the particular theorem, that is, he tries to prove that Carnot wrongly assessed the efficiency of a reversible cycle as $1 - (T_2/T_1)$.

The real thermal efficiency, as Dr. Haldane correctly says, is given by the fraction $(H-h)/H$, when H is the total heat communicated to the working substance and h the heat energy or heat equivalent of the work lost in recompression, but, by total heat communicated, Dr. Haldane says he means the heat supplied from the source during isothermal expansion, *plus* the heat accumulated in the working substance during adiabatic compression. This reasoning leads for the efficiency of the Carnot cycle to

$$\left\{\frac{T_1 - T_2}{T_1 + \dfrac{(K_v T_1 - T_2)}{R \log_e x}}\right\}.$$

Since, however (as Dr. Haldane himself admits on p. 394 of his original paper), the work done by the engine during adiabatic expansion is exactly equal to the negative work done during adiabatic compression, it is evident that the only source from which the engine receives its heat is the external source. This is the accepted view, and it leads to Carnot's expression for the efficiency, namely, $1 - (T_2/T_1)$

ROBERT DOWSON.

C. A. Parsons and Co , Ltd.,
Heaton Works,
Newcastle-on-Tyne, January 26

Chemical Effects produced by Resonance Radiation.

DR. RIDEAL having started an investigation of reactions which we discovered last spring, and which one of us (H. S T) stated publicly in Oxford so late as last October were being further studied, it seems desirable to place on record some of the results to which such further studies have led, especially as they show a marked divergence from the results of Hirst and Rideal (NATURE, 116, 899, December 19, 1925)

We are quite unable to subscribe to the conclusion of Hirst and Rideal that hydrogen and oxygen combine very slowly both in the absence and presence of mercury vapour, and only combine rapidly in the presence of a layer of liquid mercury. Our experiments show that hydrogen and oxygen, with the concentration of mercury vapour obtained by bubbling these gases through liquid mercury at room temperatures, will combine rapidly in the presence of the resonance radiation from the cooled mercury arc Furthermore, we have shown that hydrogen peroxide is a prior product of reaction appearing in marked quantities at high rates of gas flow, whereas with slower rates of flow the peroxide formed decreases and the water formed increases. In this manner we have been able to cause the gases to react to produce either exclusively hydrogen peroxide or mixtures of this with water. We have further shown that many hundred molecules of hydrogen peroxide are produced for every mercury atom passing through the zone of radiation, and that mercuric oxide is formed The removal of mercury vapour in this manner may have given rise to the anomalous results of Hirst and Rideal. In the absence of mercury vapour, no peroxide or water is formed under our experimental conditions, but the shorter wave-lengths in the mercury arc do produce a certain amount of ozonisation, which also occurs even when mercury vapour is present.

The quantity of hydrogen peroxide produced varies with several factors; the rate and composition of gas flow, the temperature, the concentration of mercury vapour, and the intensity of illumination. We shall record in more detail elsewhere the experimental data thus obtained.

Since hydrogen peroxide is demonstrably present in the gas phase, it is obvious that a liquid mercury surface must influence the velocity in some manner, since it has long been known that hydrogen peroxide is readily decomposed at a mercury surface We have, however, no data, in a very considerable body of experimental work, which would assign any of the *photosensitised* process to the liquid mercury Nor does there appear to be any sound theoretical reason why mercury atoms in a liquid surface should be more effective than those in the gas phase. Cario and Franck showed also that the quenching of the fluorescence of mercury vapour by hydrogen was proportional to the chemical reaction which could thereby be produced Secondary effects similar to that just mentioned in the presence of hydrogen peroxide will also effect the velocity in the combination of hydrogen and ethylene and in the combination of hydrogen and carbon monoxide, in these cases, however, adversely. For we have shown that the resonance radiation causes a polymerisation of ethylene with the formation of liquid condensation products, and formaldehyde polymerises to solid products as we pointed out in our initial communication on the subject.

We are inclined to assign the variability of reaction rate in the presence of liquid mercury at room temperature entirely to variations in the concentration of mercury vapour caused by removal as mercuric oxide and irregular renewal due to skin effects on the liquid surface. By operation at higher temperatures (60°-70° C.) such variable behaviour completely disappears, as shown by one of us (A. L. M.) in a recent paper (*J Phys. Chem.*, 30, 34, 1926). Our view is strengthened by actual measurements of absorption of resonance radiation by mercury in the presence of various gases, material which will also shortly be published.

We have markedly improved the technique of the study of the chemical effects produced by resonance radiation as exemplified by the apparatus already described by one of us (A. L M.), and by a new form of apparatus, through which, by building the arc system around the quartz reaction vessel, we avoid the use of quartz-mercury arcs and can operate with Pyrex glass arcs.

HUGH S. TAYLOR.
A L. MARSHALL.
J. R. BATES.

Princeton University,
Princeton, New Jersey,
January 20.

Genes and Linkage Groups in Genetics.

IT is clearly profitless to continue this correspondence further, since Prof. MacBride will not keep to the point which I raised The correspondence started because I objected to Prof MacBride attacking the *genetical* theory of linkage owing to his disagreement with the *cytological* interpretations of the chromosome theory. To my mind, he has not only not cleared up this point, but has made confusion worse-confounded by dragging in yet a third issue, namely, the *evolutionary* question of the importance of mutations for phylogeny. I would like, however, to make the following brief remarks

(1) Prof. MacBride has not attempted to answer any of the questions I asked him in my last letter concerning linkage, but has again taken the opportunity of doing something much easier, namely, setting forth his general views about wholly unrelated topics, such as evolution. The only genetical points on which I have gathered his views are (1) that a unit-factor is a " change," which is either a slip or a grave error; (2) that a linkage-group is some sort of constitutional disease. This was, as I wrote in my last letter, the only interpretation which I could put on his statements He has not contradicted this interpretation, so that we must assume he accepts it, although I confess it seems to me to be, quite literally, meaningless. He has further stated that he "does not regard Morgan's units as having any validity whatever." This sweeping statement, of course, also denies all validity to Mendel's units and all factors assumed by subsequent Mendelian workers!

He has not even deigned to give us an explanation (which, on his views, is badly needed) of the old-established fact that whereas in some crosses involving two or more Mendelian factors, the F_2 ratios are different according to which way the factors enter the cross (*i.e.* what is usually called linkage), in other crosses they are not (*i e.* what is usually called independent assortment)

In both my previous letters I have pointed out that I was only concerned with the interpretation of certain well-known genetic facts. Prof. MacBride at one moment refers to the facts I adduced as " elementary Mendelism " and in the next breath denies that they are facts. Until he has discussed them, readers of NATURE may be pardoned if they do not accept his general condemnations.

(2) The statement that Morgan's unit-factors " are avowedly assumed in order to make his observations fit a preconceived theory " is inaccurate, as any one will perceive who looks at the article on Drosophila in " Bibliographica Genetica," vol. 2, or still better Bridges and Morgan, Carnegie Institution Publication, No 327, the section on methods

(3) As Prof MacBride has made some assertions about the unimportance of mutations in evolution, I would refer readers of NATURE to a recent summary of observations on mutations and Mendelising characters in wild species of birds by Stresemann, the well-known ornithologist, in *Verh. Deutsch. Zool Ges*, vol. 30, 1925, which shows how far this view is from the truth.

(4) I cannot leave Mr. Tate Regan's letter of January 16 without a word of comment He mentions various probably mutant characters of fish which, if I understand him aright, tend to appear together in Nature, and this set of characters he calls a " linkage-group." Mr. Regan might have made sure of the definition of a linkage-group before writing his letter I can here only assure him that if he will look the matter up he will find that his usage bears no resemblance whatever to the accepted use and definition. The characters in this case appear together owing to some common developmental cause, which quite possibly may have a single-factor genetic basis. The linkage in a linkage-group is not concerned with individual (zygotic) development, but with the distribution of genetic factors to the gametes; and it is between a number of separate unit-factors which may have no special developmental relationship. To use the term linkage-group as Mr Regan has done would be to confuse the mechanism of developmental physiology with the mechanism of segregation and distribution of the hereditary constitution.

JULIAN S. HUXLEY.

King's College,
Strand, W.C.2.

Nitrogen in the Sun.

THE occurrence of nitrogen in the sun is still an open question. No familiar lines, for example, λ3995, have yet been detected in the Fraunhofer spectrum, but the presence of the element is indicated by the cyanogen bands.

It appears that the difficulty of identifying nitrogen by its line spectrum can be traced to the nature of the spectrum itself. Under the ordinary conditions of excitation, nitrogen gives several classes of band spectra, while lines obtained under a higher stimulus, including λ3995, have been assigned by Fowler to N^+. The arc lines of nitrogen itself are evidently lost between these two stages. Kiess (*Journ. Opt. Soc. Am.*, June 1925) has recently elucidated this point. He finds that the chief lines of nitrogen lie either in the extreme ultra-violet or in the extreme infra-red, so that workers confining themselves to the usual spectroscopic region miss them completely.

Kiess has given, in the paper mentioned above, a provisional classification of the arc lines. The principal lines are in the Schumann region, λ1742·81, 1745·31, etc., . . ., but the next strongest group from λ8656 to λ8629 constitutes a *pp′* combination There is another *pp′* group at λ8200, but they come from a higher level. It is interesting to see whether these lines occur in the Fraunhofer spectrum On examining the excellent photographs of the infra-red spectrum of the sun given by Meggers (*Astro. Journ*, vol. 47, p. 1), the presence of some of the lines was clearly observed, while the others were found to occur rather faintly. A complete comparison was not possible, as the author had no access to a full list of the wave-lengths of the infra-red solar lines. Miss C. Payne in her recent monograph " On Stellar Atmospheres " does not mention the occurrence of any nitrogen line in the sun or in any low temperature star The only nitrogen line which can be identified without ambiguity in the stellar sequence is λ3995 This, however, does not occur in the sun; it occurs, according to Payne, first in the *A*o class, and Fowler assigns it to N^+.

If this identification of the arc lines of nitrogen in the sun is verified, it will enable us to fix with some definiteness the energy of dissociation of N_2. Some years ago, the present writer calculated from the experimental data of Langmuir that the energy of dissociation of N_2 is of the order of magnitude $1·50 \times 10^5$ gm calories. Recently, Eucken (*Annalen der Chemie*, Band 440, p. 111) has discussed the thermo-chemical data on this point, and he comes to the conclusion that the energy of dissociation of N_2 cannot be less than $4·4 \times 10^5$ gm. calories, or thrice the value calculated by the present writer. If this were the case, nitrogen would not be dissociated at all in the sun, and the atomic spectrum cannot occur there Calculation shows that it would be appreciably dissociated only in the *A*o class But, as we have already mentioned, these stars show the lines of N^+, coming from a level (*2s*) higher than the normal. Hence Eucken's calculations seem to be quite beyond the mark.

Eucken finds from the same line of argument that the energy of dissociation of O_2 cannot be less than $4{\cdot}25 \times 10^5$ calories.

If this were true, no atomic oxygen can occur in the sun. But it is well known that Runge has identified the oxygen triplet λλ7772, 7774, 7775 in the Fraunhofer spectrum. According to Hopfield, the excitation potential for these lines is from 8 to 9 volts, so that in the sun, oxygen is not only completely dissociated, but also a considerable fraction of O-atoms is brought to a higher level The argument is, therefore, fairly decisive that in the case of O_2, Eucken's calculations are very wide of the mark

MEGHNAD SAHA.

Physics Department,
University of Allahabad,
December 26, 1925.

Winged Pollen-grains and Flowering Plants (Angiosperms).

IN a recent discussion (Linnean Society, January 21) on the relationship between Dr Hamshaw Thomas's new race of Jurassic fossil plants, the Caytoniales, and modern flowering plants, the challenge thrown out that winged pollen-grains are not to be found among existing Angiosperms was accepted, and the genus Sararanga (Pandanaceæ) was brought forward as possessing such. This appears to be incorrect The genus was founded by Hemsley in 1894 (*Journ. Linn. Soc.*, 30, 216) on the female flowers. Later the male flowers were described by Stapf in Hooker's "Icones Plantarum," 26 (1899), and the pollen-grain is there stated to be "ellipsoideis minute papillatis," and depicted so in a figure. There is no mention of wings (air-vesicles), nor are such shown in the drawing I have myself examined the pollen from dried material and have failed to find the least trace of anything of this nature. Besides the original species (*S. sinuosa*), one other has since been added to the genus, founded only on a fruiting specimen.

Being suddenly confronted with Sararanga, as I was making my statement that winged pollen-grains do not occur among existing Angiosperms, naturally prevented my making the point I intended, especially as the genus was then new to me. Possibly also it was unknown to nine-tenths of the audience, who might therefore have left with the impression that as both the Caytoniales and Sararanga had winged pollen-grains, this feature in common favoured some affinity between them, and strengthened the supposed relationship between this new fossil group and the flowering plants generally. Hence this letter.

As the challenge is still open, my point might still bear statement The probable possession of winged pollen-grains (microspores) by the Caytoniales indicates this race of plants as having been wind-pollinated (anemophilous). Dr. Thomas, assuming on other grounds that there is an affinity between the two races of plants, argues from these winged pollen-grains that the primitive Angiosperms could not have been insect-pollinated (entomophilous). How is it, then, that such supposed primitively anemophilous Angiosperms as the Screw Pines (Pandanaceæ) and the catkin-bearing families (Amentiferæ) have not retained this efficient mechanism for the conveyance of pollen through the air? On the view held by the writer that all existing flowering plants were probably descended from entomophilous stock, and that where anemophily occurs it is derivative and not primitive as in Gymnosperms, the absence of winged pollen-grains is understandable. Perhaps geologically there has not yet been time for their evolution, even in those forms, such as some of the Amentiferæ, which were probably among the earliest to substitute anemophily for entomophily.

At the meeting, stress was laid on the resemblance between the male panicle of Sararanga and Antholithus, the probable microsporophyll of the Caytoniales. This, however, can only be superficial, unless our morphological conceptions are at fault; for we are attempting to compare a shoot-structure (inflorescence) with a leaf-structure (a sporophyll or part of one). The resemblance is also strong between the individual tuft of microspore-bearing bodies of Antholithus and the male flower of Pandanus. This again can surely have no phylogenetic significance, for there is evidence that the unisexual flowers of the Pandanaceæ have been derived by reduction from hermaphrodite ones. In the male flower of Freycinetia, a genus belonging to this family, a rudimentary gynœcium is actually present.

J. PARKIN.

Blaithwaite, Wigton, Cumberland,
January 27

The Leaping Salmon.

DR. DAVID STARR JORDAN's letter in NATURE of January 16 induces me to send a photograph which excels, I think, even that to which he refers Its beauty lies in the fact that the markings on the fish, its eye, and even its mouth, are clearly visible; in all other photographs of leaping salmon which I have seen, the fish has been a mere silhouette.

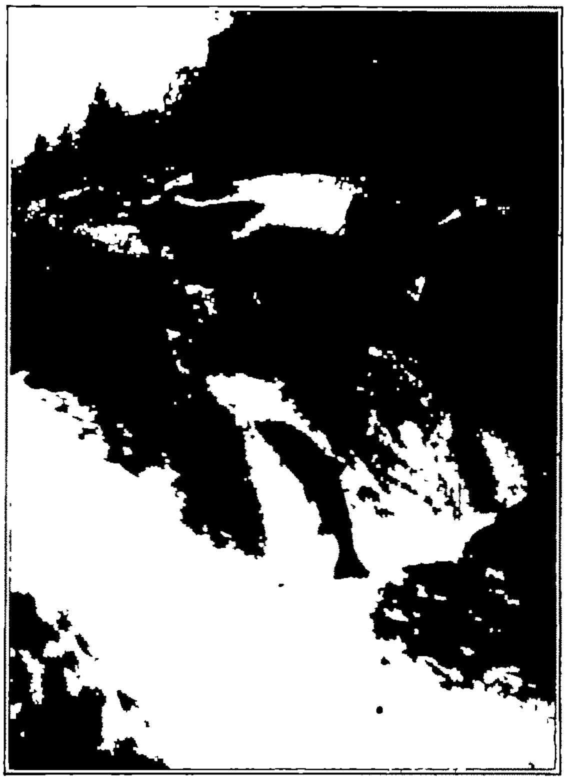

FIG. 1.

The photograph was taken at the well-known "Salmon Leap" on the River Garry at Struan, Perthshire, in August 1924. The fall is some twelve feet high, and it was an evening when the water was fairly full and the salmon were particularly lively in their efforts to scale the fall. It is possible, by scrambling down over the rocks, to get quite close to the water, and we were rather wetter than was comfortable by the time our exposures—three in all—were made. Of these, one showed a small fish, far away from the camera, one was utterly blank, and the third, here reproduced (Fig. 1), showed a fish of twenty to thirty pounds at a distance of about fifteen feet from the camera. This particular fish failed at this attempt, since it jumped more than high enough, but not far enough to reach the unbroken water above.

Often an ill-directed jump would result in a fish's striking its head against the bare rock with a crack which could be heard fifty yards off; it is a marvel to me that such a blow does not break the salmon's head, but it appears to be without effect, for they continue to come up undaunted.

The obtaining of a photograph such as this is always the accompaniment of a considerable amount of luck, and I account myself fortunate in having secured this one, which has been admired by many as a fine example of its kind.

HARRY B. WALKER.

The University,
Edinburgh, January 23.

Weather Prediction from Observation of Cloudlets.

SOME three years ago I had explained to me by an Irish land official, whose duties are largely carried out in the open air in South Kerry, a method of weather prediction which is much the same as that described in NATURE by Sir G. Archdall Reid. Attention was fixed on a small fragment of cloud, if the cloud increased in size, rain was to be expected within a few hours at most; if the cloud decreased, no rain was to be expected for some little time. I have had numerous opportunities of testing this method, and I do not recall any occasion on which the forecast made was not borne out by events.

The occasions on which my tests were made were all in unstable weather conditions of the kind in which, while hoping for a fair period, one nevertheless takes out a mackintosh to be on the safe side. These are doubtless the conditions referred to by Dr. Lockyer when he writes of "doubtful afternoons." The clouds observed were never cirro-cumuli, but always either small detached fragments of cumulus or fracto-stratus, commonly known as "scud," and at a height of, probably, not more than 3000 feet. It seems scarcely likely that in settled fine weather one would think of applying any test for imminent rain, but in such an event Capt. Cave's criticisms would no doubt be found to be well grounded. It seems possible that the differences between Sir Archdall Reid's and Capt. Cave's opinions in this matter may be due to Sir Archdall's regarding as a general method of prediction one which is applicable only in particular conditions, namely, those of showery uncertain weather, and, it may be, in particular localities; and also, to some extent, to the lack of precise definition of the type of cloud to be observed.

C. D. STEWART.

Westwood, Cahirciveen,
Co. Kerry, January 23.

Polyploidy and Sex Chromosomes.

PROF. RUGGLES GATES introduces hybridity with chromosome incompatibility as a possible source of polyploid series in plant genera. In my note I deliberately refrained from referring to this theoretical possibility because neither in intrasectional crosses nor in the widest possible intersectional willow crosses known to me does the remotest approach to total chromosome incompatibility occur. Furthermore, in my opinion, such a state of affairs is not likely to arise, or to have arisen, in Salix hybrids.

Even if it were possible, other complications, which Prof. Gates seems to have overlooked, would ensue. Consider a cross between two diploid Salix species A and B, A supplying the male parent and B the female. Let the sex chromosomes of the former species be designated X and Y and of the latter X' and Y', then, so far as the sex chromosomes are concerned, the male of A is of composition XY, and the female of B of build $X'X'$. It follows, therefore, that the hybrid males will have a sex chromosome formula of $X'Y$, and the hybrid females the composition XX'. If no reduction division takes place in hybrid sporogenesis, as the hybridity theory of polyploidy demands, the F_2 generation, although tetraploid, will have the formula $X'X'XY$, and only one sex is developed!

Prof. Gates instances several cases (to which, as a result of my own researches, I could add others both in animals and plants) in which polyploidy has originated in experimental work, but in none of these is the real difficulty raised by the failure of the duplication of the sex chromosome complement in polyploid Salices met. By quoting from the work of my colleague Dr. Blackburn and myself ("A Preliminary Account of the Chromosomes and Chromosome Behaviour in the Salicaceæ," *Annals of Botany*, vol. 38, p. 361, 1924) on the cytology of Salix in which we found peculiar relationships in respect to chromosome size, and by postulating secondary changes, he simply emphasises my original statement that, by the discovery of only one pair of heterochromosomes in the males of polyploid willows, the origin of polyploidy is thrown open for further consideration.

In conclusion, whilst directing attention to the innocent-looking remarks on the transformation of sex chromosomes into autosomes, I venture to leave them, with their far-reaching implications, to provoke their own comments

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Mutant Groups in Nature, *Gentiana campestris* var. *alba*.

PROF. JULIAN HUXLEY (NATURE, October 3, 1925, p 497) may be glad to know that his example of mutant white-flowered *Gentiana campestris* has its analogue in Zetland. There, on the slopes of Whiteness Voe, is a very large group of white-flowered specimens, outnumbering the normal form, and I saw several good-sized patches in the remote island of Balta. There is also a considerable group on the slopes of Ben Lawers and on Glen Lyon. I saw no intermediates, although in the Isle of Wight there is a large colony of white Origanum and intermediates which are also almost certainly crosses of the white and normal plants. One might add that I brought a single red-flowered *Kentranthus ruber* to my garden about twelve years ago; seedlings came up and they remained constant, but last summer a white-flowered plant appeared. However, there seems to be a permanence in the white-flowered *Gentiana campestris* and in the albino *Geranium Robertianum* which continues for many years. It was very noticeable on one side of the Brazen-face outside Funchal; there it evidently seeded down the hill-slope.

G. CLARIDGE DRUCE.

Optical Rotatory Dispersion.[1]

A TRIBUTE TO THE MEMORY OF BIOT (1774–1862).

By Prof. T. M. LOWRY, F.R.S.

LAST year, in Amsterdam and in Paris, we celebrated the jubilee of the foundation in 1874 of the science of stereo-chemistry. The year before, in Paris and in Strasbourg, the centenary of the birth in 1823 of Louis Pasteur was commemorated. This series of celebrations would be incomplete unless it covered also the 150th anniversary of the birth in 1774 of the French physicist, Jean Baptiste Biot. For, apart from Biot's pioneer work on optical rotatory power, there could have been no discovery of molecular dissymmetry by Pasteur; and, apart from the study of molecular dissymmetry, we should have known very little of "chemistry in space."

THE DISCOVERY OF ROTATORY DISPERSION.

One might have supposed that the discovery of optical activity would have preceded that of rotatory dispersion; that, after the rotation of the plane of polarised light had been discovered, further research would have shown that this rotation varied with the wave-length of the light. This, however, is the opposite to what actually happened, for it was the colours resulting from the unequal rotation of light of different wave-lengths by a plate of quartz that first attracted the attention of Arago (*Mém. Inst.*, 1811, 12, 93) and thus led to Biot's discovery of the laws of optical rotation.

In view of the fact that Biot was thus led to a knowledge of optical rotatory power through a study of the phenomena of rotatory dispersion, it is not surprising that he always included measurements of dispersion in his work on optically active substances. The example thus set would probably have been followed generally, but for the discovery in 1866 of the Bunsen burner. This device, which made it easy to produce monochromatic light of one colour, was fatal to the study of dispersion, since no other monochromatic light could be produced with equal ease. The custom therefore arose of measuring the optical rotatory power of organic compounds for one wave-length only; and even physical chemists, seeking to discover the influence of solvent, concentration, temperature or chemical constitution on rotatory power, were content to work with sodium light only, and thus to record a single point on a curve of unknown form. Biot, however, always recognised the supreme importance of dispersion in his studies of optical rotatory power, and this fact alone brings his work into closer relation with the researches of the twentieth century than with those of the nineteenth.

THE LAW OF INVERSE SQUARES.

In his first memoir (*Mém. Inst.*, 1812, 1, 1-372) Biot only recorded the fact that the rotations produced by a plate of quartz decreased progressively with change of colour from violet to red (pp. 256-257). In his second memoir (*Mém. Acad. Sci.*, 1817, 2, 41-136), however, he undertook a more exact "Recherche de la loi des rotations des différens rayons simples dans le cristal de roche," and as a result he was able to announce immediately his well-known Law of Inverse Squares, $\alpha = k/\lambda^2$. For this law Biot was able to claim that "si elle n'est pas la loi de la nature elle en approche du moins assez pour pouvoir lui être substituée dans toutes les observations" (p. 85). It is noteworthy that Biot arrived at this important law in spite of the fact that he had no source of monochromatic light, and that his only wave-lengths were Newton's values for the boundaries of the different colours.

Special interest attaches to the graphical method which Biot used in order to express his Law of Inverse Squares. For this purpose Biot plotted along a horizontal axis the square of the wave-length of the light, and in a vertical direction the thickness of the plates of quartz required to produce rotations of 180°, 360°, 540°, etc., in light of a given colour. The law of inverse squares was verified (i) by a linear relation between $1/\alpha$ and λ^2, (ii) by noticing that the line passed through the origin, *i.e.* that on extrapolation to $\lambda^2 = 0$, $1/\alpha$ became 0 also, and α became infinite.

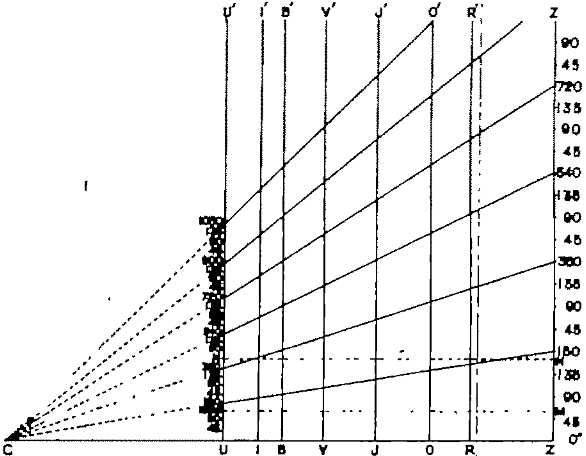

FIG. 1.—Biot's linear diagram. This diagram, in which the reciprocal of the rotatory power of quartz is plotted against the square of the wave-length of the light, is of the same type as those now used in the graphical method of testing for "simple rotatory dispersion."

Having established the law of inverse squares for quartz, Biot at once proceeded to apply it to those liquids in which he had just discovered the existence of optical rotatory power, and in particular to oil of turpentine (pp. 91-103), and to an aqueous solution of cane-sugar (pp. 103-114). The method adopted was to balance the rotation of the liquid against that of quartz plates selected so as to produce an equal and opposite rotation in the light transmitted through a piece of deep red glass. In each case the compensation appeared to be exact, proving that the law of inverse squares applied just as well to the liquid as to the rock crystal. Some years later, however, when trying to compensate lævorotatory turpentine against a dextrorotatory oil of lemon, either in separate tubes or mixed, Biot observed "une compensation très approchée, mais non pas complète, ni surtout générale pour tous les rayons" (*Comptes rendus*, 1836, 2, pp. 542 and 543). A very exact compensation was obtained when cane-sugar and invert-sugar were balanced against one another (*Ann. Chim. Phys.*, 1844, 10, 35), but the experiments with turpentine and oil of lemon proved clearly that the law of inverse squares was not exactly and universally true

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[1] From a lecture delivered before the Société de Chimie Physique, in Paris, on December 9, 1925.

What then must be done in order to find the exact law of rotatory dispersion? Biot had the key in his own hands, and could have solved the problem with certainty if the experimental methods then available had provided data of sufficient exactness for a rigid test of the law. Thus, it is only necessary to plot $1/\alpha$ against λ^2 for a series of optically-active compounds, in order to discover that there is often an exact linear relationship between these two quantities. The straight line does not pass, however, through the origin at $\lambda^2 = 0$, but intersects the axis of zero rotation at a finite distance from the origin, *e.g* at a point given by $\lambda^2 = \lambda_0^2$. The true law of rotatory dispersion is therefore not $\alpha = k/\lambda^2$, but $\alpha = k/(\lambda^2 - \lambda_0^2)$.

It is a remarkable fact that, although Biot discovered the law of inverse squares in 1818, and discovered the errors in the law in 1836, it was not until about 1898 that Drude, as a result of a long theoretical inquiry, first enunciated the true law of rotatory dispersion in the general form $\alpha = \Sigma\frac{k_n}{\lambda^2 - \lambda_n^2}$; and even then several years elapsed before it was first shown, in 1913, that the general equation (which Drude had applied only in the case of quartz) could be used in its simplest possible form in order to express the rotatory dispersion of a large range of simple organic compounds (Lowry and Dickson, *Journ Chem. Soc.*, 1913, 103, 1067). If later workers had possessed Biot's peculiar mathematical genius, as well as his experimental skill, this law would surely have been discovered and verified nearly half a century earlier.

THE DISCOVERY OF ANOMALOUS ROTATORY DISPERSION.

The first reference to the optical rotatory power of tartaric acid is contained in a "Mémoire sur la polarisation circulaire et sur ses applications à la chimie organique" (*Mém. Acad.*, 1835, 13, 39-175). At the conclusion of a list of optically-active oils and syrups, it is recorded that a certain solution of tartaric acid gave a rotation of +8·5° for white light, and that the rotation was "plus forte sur les rayons les moins réfrangibles" The memoir itself, which records in a "note additionnelle" the important discovery of the inversion of cane-sugar (pp. 174-175), does not appear to contain any reference to this entry in the table; but three years later, Biot presented to the Academy a long memoir (*Mém. Acad. Sci.*, 1838, 15, 93-279) devoted entirely to the study of the rotatory power of tartaric acid under different conditions. In this memoir, stress was laid on the fact that tartaric acid was almost unique in its failure to obey the law of inverse squares. The existence of a *maximum rotatory power* for green light was indicated in a table (p. 236), which shows the rotation for light of different colours of a solution containing 34·27 per cent. by weight of tartaric acid. The memoir also contains a clear prediction of the existence of a second form of anomaly, namely, a *reversal of sign*, as indicated by the fact that the limiting values for 0 per cent. of water were negative for low temperatures and for short wave-lengths. This prediction was fulfilled when Biot, in 1850, found a negative rotation in the cold, glassy, anhydrous acid (*Ann. Chim. Phys.*, 1850, 28, 353) The more elaborate work of Bruhat (*Trans. Faraday Soc.*, 1914, 10, 89) has shown that, under these conditions, negative rotations are observed at 15° C. for all wave-lengths less than 5600 Å.U. Negative rotations have also been observed repeatedly in subsequent years, especially in concentrated solutions, and for light of short wave-length (see especially Lowry and Austin, *Phil. Trans.*, 1921, A, 222, p. 280).

SIMPLE AND COMPLEX DISPERSION.

Biot divided optically-active substances into two classes: (i) those which obeyed, at least approximately, the Law of Inverse Squares, (ii) those which made no pretence of obeying it. In the latter class he included tartaric acid, whilst its salts were included in the former class.

These two classes are now generally described as showing *normal* and *anomalous* rotatory dispersion respectively. The distinction between them depends on whether the dispersion-curve remains on the same side of the axis throughout the region of transparency (so that α, $d\alpha/d\lambda$, and $d^2\alpha/d\lambda^2$ are of constant sign), in which case the rotatory dispersion is *normal*, or whether it cuts the axis of zero rotation in the region of transparency, in which case the dispersion is *anomalous*. In the latter case the dispersion-curve exhibits all the well-known anomalies, *e.g.* an *inflexion*, *maximum* and *reversal of sign*; but, as these become less marked, they vanish successively into the infra-red region, where we have no means of following them experimentally. It is therefore impossible in many cases to decide whether a dispersion is really normal, or whether the dispersion-curve may be expected to cut the axis at some wave-length beyond the limit within which visual readings can now be made.

In my own work I have adopted Biot's original classification, with one essential modification, namely, that I have substituted the equation $\alpha = k/(\lambda^2 - \lambda_0^2)$ for Biot's Law $\alpha = k/\lambda^2$ Substances of which the rotatory power can be expressed by the equation $\alpha = k/(\lambda^2 - \lambda_0^2)$ are said to show *simple rotatory dispersion* (Lowry and Dickson, *Trans Faraday Soc.*, 1914, 10, 961; Lowry and Richards, *Journ Chem. Soc.*, 1924, 125, 2511), whilst substances which do not obey the law of simple rotatory dispersion are said to exhibit *complex rotatory dispersion* The difference between a simple and complex dispersion is seen most clearly in the ultra-violet region, where the course of the dispersion can be followed right up to the limit of transparency of the medium, within which alone the dispersion-equations are valid. I therefore prefer to retain, in this modified form, Biot's original method of classifying rotatory dispersions, according as they do or do not obey a certain law, rather than to be guided exclusively by the presence or absence in the visible spectrum of gross anomalies, such as an inflexion, maximum or reversal of sign

Although only a small correction is needed in order thus to convert Biot's law into the Law of Simple Rotatory Dispersion, this correction is of great importance, since if all optically-active substances obeyed the Law of Inverse Squares, all rotatory dispersions would be normal, and all would be identical with one another, *e.g.* $\alpha 4358/\alpha 5461 = (5461)^2/(4358)^2 = 1{\cdot}52$. The superposition of two normal dispersions, even if of opposite signs, would then always give rise to a normal dispersion of the same magnitude, and no form of anomalous rotatory dispersion could be developed by this process.

THE ORIGIN OF ANOMALOUS ROTATORY DISPERSION.

(*a*) *Anomalous Rotatory Dispersion produced by Optical Superposition.*—The secret of the origin of anomalous rotatory dispersion was disclosed by Biot in 1836, when he showed that ***anomalous rotatory dispersion can be produced in transparent media by the superposition of two normal rotations of opposite sign and of unequal dispersion.*** This superposition may be entirely optical, *i.e.* two independent columns of liquid may be balanced against one another by inserting them end to end in the same polarimeter; or the liquids may be mixed in the same tube. Both methods were used by Biot in compensating lævorotatory turpentine against dextrorotatory oil of lemon, in the experiments already described (*Compt. rend.*, 1836, 2, 543).

These two cases are easily understood, since the existence of two independent partial rotations of opposite sign can be demonstrated quite conclusively. Much more complicated are those cases in which a single optically-active compound, such as tartaric acid or α′-bromocamphor, gives rise to anomalous dispersion, since in these cases it is impossible to isolate from the medium a dextrorotatory and a lævorotatory component. Here again, however, a correct lead was given by Biot when he described his researches on the rotatory power of tartaric acid, under the title "Mémoire sur plusieurs points fondamentaux de mécanique chimique," since he evidently regarded the problem as fundamentally chemical and not merely physical in character.

(*b*) *Origin of Anomalous Rotatory Dispersion in Tartaric Acid.*—Biot's view that the changes of rotatory power which tartaric acid undergoes under the influence of bases, of boric acid, of water and of alcohol, are chemical in origin, was developed in a more concrete form by Arndtsen, who spent the summer of 1858 in working on rotatory polarisation in the laboratory of M. Verdet at the École Normale Supérieure.

To Arndtsen's view, that the anomalous rotatory dispersion of tartaric acid is due to the superposition of the opposite rotations of two interconvertible forms of the acid, I have given consistent support. In addition to making a careful study, during a period of more than twenty-five years, of the conditions under which a reversible isomeric change can take place in solution, I have proved (Lowry and Cutter, *Journ. Chem. Soc.*, 1925, 121, 532) that the anomalous rotatory dispersion at 20° C. of pure recrystallised ethyl tartrate can be expressed with perfect accuracy *as the sum of two simple partial rotations*, by means of the equation

$$[\alpha] = 20{\cdot}005/(\lambda^2 - 0{\cdot}03) - 20{\cdot}678/(\lambda^2 - 0{\cdot}056).$$

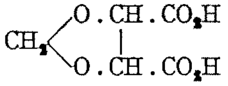
This dispersion is anomalous, and a simple calculation serves to locate the ***inflexion*** at 6950 Å.U., the ***maximum*** at 5630 Å.U., and the ***reversal of sign*** at 4245 Å.U. In the same way the rotatory power of a 50 per cent. solution of tartaric acid in water at 20° C. can be expressed (Lowry and Austin, *Phil. Trans.*, 1922, A, 222, p. 293) by the equation

$$[\alpha] = 17{\cdot}485/(\lambda^2 - 0{\cdot}03) - 12{\cdot}080/(\lambda^2 - 0{\cdot}074).$$

This dispersion is anomalous, like that of the ester, and calculation shows (in agreement with direct experiment) that the ***inflexion*** occurs at 6376 Å.U., the ***maximum*** at 5373 Å.U., and the ***reversal of sign*** at 4140 Å.U.

The latter equation is of interest because Longchambon (*Compt. rend.*, 1924, 178, 951; *Bull. Soc. fr. Min.*, 1922, 45, 161) has proved that solid tartaric acid is lævorotatory and has a "normal" dispersion. Moreover, it gives a dispersion-ratio $\alpha 4358/\alpha 5780 = 2{\cdot}14$, which agrees closely with the ratio 2·2 deduced ***for the negative partial rotation*** in the above equation (Lowry and Austin, NATURE, Sept. 20, 1924, 114, 430). There can, therefore, be little doubt that this negative partial rotation is due to the persistence in the solutions, as Biot postulated, of unchanged molecules of the solid acid, which Longchambon describes as α-tartaric acid. Conversely, the positive partial rotation in our equation can be attributed to the presence of the β-tartaric acid, which Longchambon supposes to be formed by a reversible chemical change from the α-acid, just as Biot postulated ninety years ago.

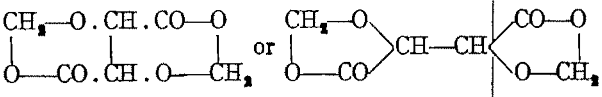
This view of the origin of the anomalous rotatory dispersion of tartaric acid is confirmed by the fact that it is possible to prepare dextrorotatory and lævorotatory derivatives of tartaric acid, the rotatory dispersions of which are not merely ***normal*** but ***simple***, like the two partial rotations of the above equations. Thus the rotatory power of ***methylene-tartaric acid***,



(Austin and Carpenter, *Journ. Chem. Soc.*, 1924, 125, 1939), can be expressed by the equation

$$[\alpha] = -24{\cdot}627/(\lambda^2 - 0{\cdot}0446),$$

whilst the rotatory power of ***dimethylene tartrate***,



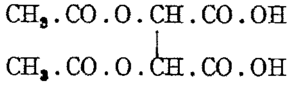
can be expressed (*ibid.* p. 1945) by the equation

$$[\alpha] = +34{\cdot}168/(\lambda^2 - 0{\cdot}03132).$$

There can be little doubt that the lævorotatory compound is a derivative of pure α-tartaric acid, whilst the dextrorotatory compound is a derivative of pure β-tartaric acid. This conclusion is confirmed by the fact that, although the dispersion constants are not identical with those of the two partial rotations in the above equations (which are themselves variable from compound to compound), the dextrorotatory compound has a smaller dispersion constant than the lævorotatory compound.

Exceptional interest attaches to the acetyl-derivatives. In this case, Austin and Park have shown

(*Journ. Chem. Soc.*, 1925, 127, 1926) that the rotatory power in dry acetone of *diacetyl-tartaric acid*,

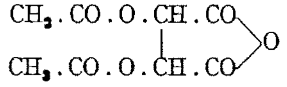


$$\begin{array}{l} CH_3.CO.O.CH.CO.OH \\ \qquad\qquad\quad | \\ CH_3.CO.O.CH.CO.OH \end{array}$$

can be expressed by the equation

$$[\alpha] = -6{\cdot}508/(\lambda^2 - 0{\cdot}0833).$$

In the same way the rotatory power in dry acetone of *diacetyl-tartaric anhydride*,



$$\begin{array}{l} CH_3.CO.O.CH.CO \\ \qquad\qquad\quad |\qquad\quad >O \\ CH_3.CO.O.CH.CO \end{array}$$

can be expressed by the equation

$$[\alpha] = +18{\cdot}354/(\lambda^2 - 0{\cdot}0507).$$

In this case again, therefore, the rotatory dispersion of the two derivatives is simple, and the dextrorotatory compound has the smaller dispersion constant. In wet acetone, however, the anhydride is not stable, and is gradually hydrolysed to *diacetyl-tartaric acid*. Since the rotations of the two compounds are opposite in sign, and their dispersion constants are of unequal magnitude, all the conditions necessary to produce anomalous dispersion are present in the solution. Thus, a freshly prepared solution of the anhydride, which gave a *simple dextrorotation*, soon showed a *complex and anomalous dispersion*, owing to the development in the free acid of a negative partial rotation with a high dispersion coefficient. This complex and anomalous dispersion was transformed in turn into a *complex and normal dispersion*, when the negative term had become predominant over the whole range of wave-lengths; and finally, when hydrolysis was complete, the solution showed only the *simple lævorotation* of the free acid (Austin and Park, *loc. cit.*). This case is of special importance, since it provides a working model of the mechanism postulated by Biot, by Arndtsen, and more recently by Longchambon, in order to account for the development of anomalous rotatory dispersion in solutions of the free acid.

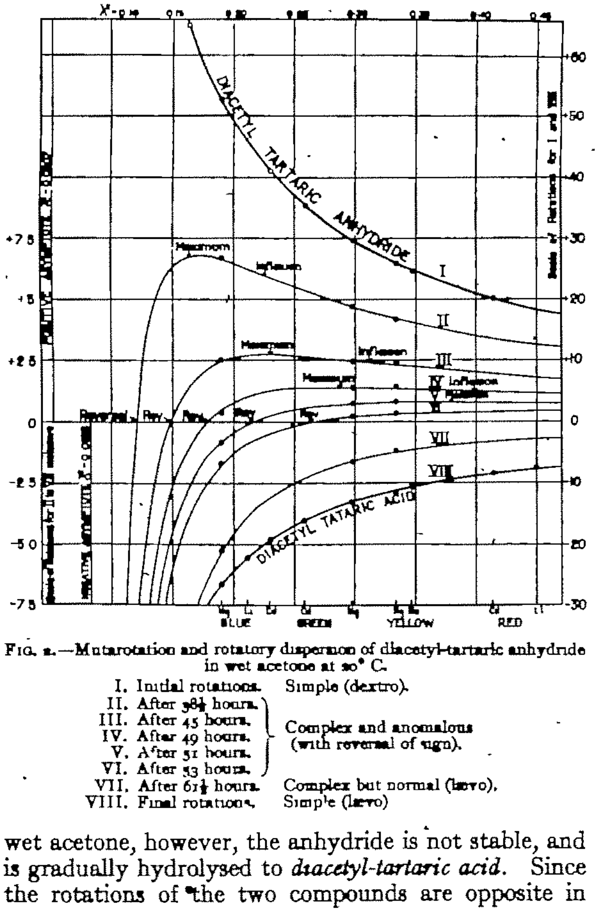
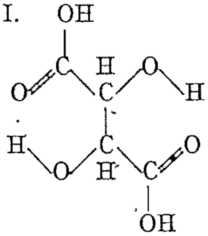


FIG. 2.—Mutarotation and rotatory dispersion of diacetyl-tartaric anhydride in wet acetone at 20° C.

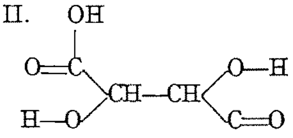
I.	Initial rotations.	Simple (dextro).
II.	After 38½ hours.	Complex and anomalous (with reversal of sign).
III.	After 45 hours.	
IV.	After 49 hours.	
V.	After 51 hours.	
VI.	After 53 hours.	
VII.	After 61½ hours.	Complex but normal (lævo).
VIII.	Final rotations.	Simple (lævo)

The ease of transformation of α into $\alpha \rightleftharpoons \beta$ tartaric acid suggests that the difference between the two compounds involves a rearrangement of structure which is even less drastic than a keto-enolic change. I therefore formed the opinion some years ago that the difference between the two forms of the acid might depend merely on an arrest, in two favoured positions, of the free rotation of the molecule about the single bond between the two central carbon atoms. The clear recognition of the bivalency of hydrogen (Lewis, "Valence," 1923, p. 109; Lowry and Burgess, *Journ. Chem. Soc.*, 1923, 123, p. 2111; Lowry, "Nouveaux aspects de la théorie de la valence," *Bull. Soc. Chim.*, 1924, p. 9) has, however, made it possible to assign to tartaric acid alternative formulæ I. and II. (Lowry and Austin, NATURE, 1924, 114, p. 431) which appear to fulfil all the essential conditions required for a graphical representation of the α- and β-tartaric acid of Longchambon. There is, however, not enough evidence available to show which of these formulæ should be assigned to α-tartaric acid and which to β-tartaric acid.

I.



II.



(*c*) *Origin of the Quasi-anomalous Rotatory Dispersion of Camphor.*—Although the rotatory dispersion of camphor is *normal*, it depends on the superposition of two partial rotations of opposite sign, and is therefore *quasi-anomalous* (Lowry and Cutter, *Journ. Chem. Soc.*, 1925, 127, p. 608). What, then, is the origin of these two opposite partial rotations? Tschugaeff has shown that anomalous rotatory dispersion can be produced by superposing the opposite partial rotations of two radicals in the same molecule, as in *l*-menthyl *d*-camphorsulphonate (*Trans. Faraday Soc.*, 1910, 10, 73). I have adopted this view in the case of camphor, with a novel assumption as to the nature of the asymmetric radicals. Thus I suppose that the high-frequency negative partial rotation of camphor is associated with the two saturated quadrivalent asymmetric carbon atoms. On the other hand, it is clear that the positive partial rotation, which is controlled by a dispersion constant corresponding approximately with the wave-length of the ketonic absorption-band (Lowry and Cutter, *Journ. Chem. Soc.*, 1925, 127, 611), is in some way linked up with the double bond of the $>C=O$ group. I have therefore suggested (Lowry and Walker, NATURE, April 19, 1924, 113, 565) that although a carbonyl radical in a symmetrical molecule possesses a plane of symmetry, this is no longer true in an unsymmetrical molecule. As evidence of this absence of symmetry, I have adduced the fact that camphor gives unequal yields of borneol and isoborneol on reduction, proving that the two links of the double bond are of unequal strength. It is, therefore, a mere unjustified analogy which has led to the assumption that the carbonyl-group of camphor is a symmetrical radical, and no further evidence is required to justify the view that the carbon atom of the ketonic group is in fact an asymmetric carbon atom, *i.e.* that it possesses an *induced asymmetry*, in view of the influence upon it of the *fixed asymmetry* of two of the saturated quadrivalent carbon atoms. This property of induced asymmetry appears to be very frequent in unsaturated optically-active compounds, and can be used in order to account for the presence of low-frequency partial rotations in many compounds in which the unsaturated group is not too far removed from the fixed asymmetric centres.

In this address I have presented an intimate mixture of Biot's researches with those of my colleagues of the present day. The fact that so intimate a blend is possible is in itself a tribute to the genius of Biot, whose work, although carried out with the mechanical equipment of the nineteenth century, was always conceived in the spirit of the twentieth century.

The American Bison: A Questionable Experiment.

By Dr. James Ritchie.

Thirty-eight years ago the sum total of American bison had been reduced from the millions of a century earlier to a number estimated by Hornaday at 1091, and there was a prospect that the species might become extinct. The situation was saved by the action of the Governments of the United States and of Canada, each of which placed remnants of the dwindling herds under protection in large reserved areas. The rapidity with which the protected animals recuperated is well illustrated by the history of the Canadian herd. In 1907 the Dominion Government, acting through the Department of the Interior, purchased the 709 members of the herd owned by Michael Pablo of Montana, which can be traced back to 4 wild calves captured by an Indian in 1873. By 1909 the Pablo herd had been set at large in the Buffalo National Park at Wainwright, an area 15 miles long and 13 miles wide, and in 1925 this herd was found to number approximately 12,000 head, the increase in sixteen years being about 11,300. The future of the species in Canada, therefore, seems to be assured. So far, the success of the experiment of protection has been all that could be desired.

A new difficulty now faced the authorities in Canada. The area of close on 200 square miles set aside for the original herd was insufficient to support the new numbers, and some method of reducing the numbers and of disposing of the annual increase had to be devised. Some 2000 have been slaughtered for food and robes, some have been transferred to other parks, including a pair sent to the Scottish Zoological Park in Edinburgh, and more than 1600 have been transported northward for 700 miles to Wood Buffalo Park in the North-West Territories. The Wainwright stock now reduced to about 8000, or about one to 16 acres, must be still near the food limit of the area (10 acres to one sheep is a rough guide to the food capacity of Scottish mountain pastures), but arrangements are being made for the disposal of the annual increase, which in the full herd amounted to 1500 individuals a year. It is, however, to the transference of large numbers to Wood Buffalo Park that attention is here particularly directed.

The Department of the Interior is to be congratulated on the success of the work of transference; for, by means of specially designed cars and barges, 1634 bison were moved by rail and water for 700 miles with only 8 casualties. But the transference gives rise to some doubt from the scientific point of view.

In Wood Buffalo Park there existed the only herd of wild bison which has survived, and these, the "wood buffalo," have been separated from the "plains buffalo" of the reserves as a distinct race, *Bison bison athabascæ*, characterised by its larger size, darker colour, more dense and silky hair, and larger and more incurved horns. Whether these characters are due to innate variation emphasised by segregation, or are simply the evidences of the effect of a different environment, is not known. At any rate, this race has now little likelihood of survival as a pure strain, for amongst its members, which probably do not exceed 1500 in number, have been deposited 1600 individuals of the contradistinctive race of the plains; and the wardens report that "the plains and the wood buffalo are mingling freely and that there is every prospect of the complete amalgamation of the two herds."

From the scientific point of view the opportunity of making an interesting experiment has been missed. Had the surplus plains buffaloes been deposited in an area similar in latitude, vegetation and climate to Wood Buffalo Park, but isolated from it, instead of in the Park itself, the wood buffalo race would have remained uncontaminated, and time would have shown whether in the new environment the plains buffalo would have assumed the distinctive characters of the wood buffalo. Had it turned out that these characters were wholly environmental, as they may well be, an interesting biological correlation would have been proved, and no objection could then have been taken to fortifying the wood buffalo herd by the addition of plains individuals.

In the meantime two suggestions may be made. First, in view of the possible swamping and disappearance of the distinctive wood buffalo as the result of crossing, it should be assured that several pure-bred typical specimens of that race find a place in one or more of the Dominion or other great museums. Secondly, if it be possible, the next batch of surplus plains buffaloes to be transferred from Wainwright should be placed in a northern area other than Wood Buffalo Park, with the view of establishing a new and independent herd in which the influence of climate might be watched. The result would finally condemn or vindicate the 1925 experiment of commingling the two racial forms.

Obituary.

MR. B. N. PEACH, F.R.S.

THE death of Benjamin Neeve Peach on January 29 has removed one of the most conspicuous figures from the Scottish geological world. Born in 1842, he had retired from the Geological Survey of Scotland in 1905, but advancing years and recurrent attacks of rheumatic gout did not prevent him from taking a keen interest in every kind of investigation and discovery in the fields of research which he had cultivated.

Peach was born in Gorran, Cornwall, and his father, Charles W. Peach, was a notable man, who, although a Customs officer of comparatively humble station, had trained himself in geology and biology until he was well known for his original contributions to natural science. He was the friend of Sir Roderick Murchison, Hugh Miller, Robert Dick, and many other eminent scientific workers. The boy attended school at Peterhead and Wick (Caithness) and passed on to the Royal School of Mines (London), where he studied under Huxley, Ramsay, and many of the first teachers and investigators of the time. Benjamin Peach entered the Geological Survey in due course, and after a short period of work in London with Salter, the palæontologist, started field work on the Scottish staff. His colleagues included such men as Archibald Geikie, James Geikie, John Young, and at a later date, W. Gunn and John Horne, men of brilliant ability who were destined to make their department famous by their researches. At their head were two great geologists, Sir Roderick Murchison and Sir Andrew Ramsay. Each of the group had his individual merits and claims, but Peach in some ways was the most brilliant of them all.

The love of biology, which Peach probably acquired from his father, was one of his principal interests. For many years he acted as palæontologist to the Geological Survey of Scotland and did a vast amount of routine work. His special field, however, was the fossil Crustacea, and on these he has left some short monographs and papers. He ascribed his interest in this group to the teaching of Huxley, and by his high artistic skill he was able to furnish all the drawings required to illustrate the memoirs.

It was as a field geologist, however, that Peach especially shone. His experience was vast, for there was scarcely a parish in Scotland in which he had not worked or visited at some period. His early work was in the Scottish Midland valley, where a great variety of rocks, sedimentary and igneous, lay open to his scrutiny, and the glacial and alluvial deposits were of great diversity and presented many problems then awaiting solution. In course of time he began work in the Highlands and was one of the leaders of that band who settled the obscure questions involved in the great thrust zones of the north-west. From there his work spread over many parts of that delightful but puzzling country. When Lapworth's discoveries in the Scottish Silurian rocks necessitated revision of the published maps, Peach and Horne undertook the work and carried it to completion with triumphant success.

Peach's wide experience of field work, however, was only one of the factors that contributed to his pre-eminence. Peach had in especial degree the gifts that make a great field geologist. With great physical strength and activity, he combined a restless passion for investigation that left no stone unturned that seemed likely to conceal some evidence. He had the most wonderful ingenuity and an imagination that amounted almost to inspiration. In difficult ground where the evidence was scanty and obscure, he tried every possible hypothesis and his judgment was seldom at fault. With these he had the rarest faculty of all, that of seeing in three dimensions, and in all sectional planes, the structural anatomy of the country he was mapping; so that each bit of evidence was fitted immediately into its place. No other geologist of his time had this faculty in the same measure except Charles Lapworth of Birmingham.

To his great gifts as a geologist were added the most charming personality and a striking physique. To his last days Peach had the boisterous spirits of a schoolboy. Full of humour and endowed with innumerable good stories, which he retailed in broad Scotch, he was a centre of attraction in every social gathering. His influence on young men was remarkable, and probably the greatest service he did to science was the training he gave to successive generations of young geologists, partly by precept (of which he was very lavish) but principally by example and by lessons in the field. To accompany Peach for a few weeks in the field (in the Highlands especially) was a liberal education for a young geologist; and by his rich store of recollected facts, his penetrating acuteness in observation, his rapid and logical deductions, and the lightning-like rapidity with which he read the riddles of geological structure, he inspired his assistants with a love of the work and a knowledge of the best and most rapid methods of getting accurate results. It was not easy going, for Peach made each field day an arduous task, both physical and mental, but the reward was certain.

In the study and the office Peach was a different man. His knowledge of geological cartography was profound, and his drawings, sketches, sections and maps were never at fault and were often of the greatest merit. As a writer, however, he was less successful. He hated the slow labour of the pen. Although fluent of speech, he was a slow and involved writer, and only by patient effort could he express his thoughts in clear sequence and exposition. Fortunately, however, his defects were more than compensated by the great literary skill of his friend and colleague Dr. John Horne, who formed with Peach a partnership that produced many geological monographs now known as classics in every country where geology is studied. Ably supported by their colleagues, these two geologists achieved magnificent results in many fields of geological work. Their faculties blended so perfectly that each produced his best in their joint enterprises, and they have dominated the progress of Scottish geology for the last forty years.

The list of geological papers, monographs, and memoirs to which Peach contributed is a very long one, but they mark only a portion of his activities. His published maps and the manuscript maps that show his field results are to the initiated even more instructive. Such work, for example, as his survey of parts of Assynt, of Arthur's Seat, and of the graptolite zones of the south of Scotland, indicates the hand of the master. For many years he gave devoted service to the geological mapping of Scotland, and so long as men take interest in Scottish geology his memory will endure.

J. S F.

DR. W. E. HOYLE.

THE death of William Evans Hoyle, D.Sc. (Oxon.), on February 7, at Porthcawl, has removed from this world one who, to the deep regret of his many friends, had for the last year or two been compelled by ill-health to withdraw entirely from that active participation in their pursuits to which for half a century they had been accustomed.

Born at Manchester, in 1855, Hoyle was by circumstances inclined to the profession of his father, William Jennings Hoyle, an engineer connected with both Whitworth's and Armstrong's. But his education at Owens College and afterwards at Oxford, which he entered as an exhibitioner in natural science at Exeter College, being elected later a junior student of Christ Church, turned his thoughts to the mechanism of the animal body, and this attraction was intensified by the influence of the great teacher, Rolleston. Thus it was that, after taking a first class in natural science, and qualifying at St. Bartholomew's Hospital for M.R.C.S., Hoyle was glad to become demonstrator in anatomy at Owens College and, not long after, to migrate to Edinburgh as a naturalist on the editorial staff of the *Challenger* Expedition. This division of interests bore at first similarly divided fruit: the year 1883 saw papers by him on primary epithelioma of the lung and on a new species of Octopus, while 1886 produced his translation of Leuckart's "Parasites of Man" as well as his report on the Cephalopoda collected by the *Challenger*. After this it was the cephalopods that conquered; on that fascinating group Hoyle produced a series of reports and papers, including reports on the cephalopods collected by Herdman at Ceylon (1904), by Stanley Gardiner at the Maldives and Laccadives (1905), by the National Antarctic Expedition (1907), and the Scottish National Antarctic Expedition (1912). Valuable and thorough though they were, these works did not introduce any startling changes in our conception of the group; apart from the systematic aspect, the chief study to which they led was that of phosphorescence in the cephalopods and other animals of the deep sea. Hoyle's knowledge of recent cephalopods was summarised in his presidential address to Section D of the British Association at Leicester (1907).

Meanwhile his systematic work and his training in the *Challenger* Office had qualified Hoyle to act as curator of a large collection. A chance arose for transferring him to the Zoological Department of the British Museum, but failed owing to the opposition of the staff, which did not like to see promotion checked by the appointment of senior men from outside. There was, I know well, no objection on personal grounds. The result, whether gain or loss to the British Museum, was a gain to Hoyle's own development and to the museum world. What London rejected, Manchester seized: Hoyle was made curator of the Manchester Museum, at Owens College, and, under the guidance of Sir William Boyd Dawkins, entered on his career as a great museum curator and administrator. He studied his new profession, as all museum-men should do, from every side. Methods of exhibition, of conservation, of storage and arrangement, of registration, and of card-indexing, all benefited from his active mind He even trespassed on the field of the librarian, and was, I believe, the first in England to apply the Dewey decimal system, which he used in his catalogues of the libraries at the museum and the Conchological Society All the results of his museum experience were communicated by him to the Museums Association, of which he was an original member, becoming its president in 1906. At the yearly gatherings of that body, as in all meetings of zoologists, his sagacity and his humour were alike welcome.

When, in 1909, a National Museum was to be established for Wales, the governors took the unprecedentedly wise step of first getting a director. Hoyle was their choice, a fact which he jestingly ascribed less to his own merits than to his name "Evans." On his own suggestion, he was at once sent abroad to complete his already extensive knowledge of the great museums. The plans were drawn to his specification and emended after criticism by himself and an independent expert. To the wisdom of the governors in trusting to Hoyle's initiative and direction is due the high position of that Museum to-day. We all regretted that he should have had to retire before receiving public acknowledgment of his great services.

F. A. BATHER.

WE regret to announce the following deaths:

Prof. D. S. Capper, from 1902 until 1921 professor of engineering at King's College, London, on February 12, aged sixty-one years.

Prof. W. O. Crosby, emeritus professor of geology in the Massachusetts Institute of Technology, known for his work on ore deposits and on the geology of the Boston Basin, Alaska, and the Rocky Mountains, on December 31, aged seventy-five years.

Prof. F. Y. Edgeworth, fellow of All Souls College and emeritus professor of political economy in the University of Oxford, president in 1912–14 of the Royal Statistical Society, and joint editor for many years of the *Economic Journal*, the organ of the Royal Economic Society, on February 13, aged eighty-one years.

Dr. Ernst Ehlers, professor of zoology since 1874 in the University of Göttingen, on December 31, aged ninety years.

Dr. Sigmund Exner, emeritus professor of physiology in the University of Vienna, and a member of the Vienna Academy of Sciences, on February 6, aged eighty years.

Prof. J F Gemmill, F.R.S., professor of natural history, University College, Dundee (University of St. Andrews), and first president of the parent society of the Scottish Marine Biological Association, on February 10.

Sir John Burchmore Harrison, Director of the Department of Science and Agriculture, in British Guiana, the author of numerous papers on the chemistry of tropical products, on February 8, aged sixty-nine years.

Sir George Holmes, K.C.B., K.C.V.O., honorary member and for more than twenty years secretary of the Institution of Naval Architects, on February 13, aged seventy-seven years.

News and Views.

AN interesting address, which we hope to publish next week, upon Prof. Einstein's researches on relativity and the theory of gravitation, was delivered at the annual general meeting of the Royal Astronomical Society on February 12, by the president, Dr J. H. Jeans. The gold medal of the Society, which was awarded by the Council to Prof. Einstein, was handed to the foreign secretary, Prof. H H. Turner, for transmission to him; and with it, remarked Dr. Jeans, went "the most cordial wish of the whole Society that the future may bring with it health, vigour and further scientific triumphs of the kind that have already made him one of the outstanding figures of modern science; and I think we may anticipate the verdict of posterity and add, one of the outstanding figures also in the history of human thought." The following translation of a letter from Prof. Einstein, acknowledging the award of the medal, was read to the meeting: "He who discovers a line of thought which permits us to penetrate even a little deeper into the eternal mystery of Nature, is greatly privileged. He who, in addition, is encouraged by recognition, sympathy and help from the best minds of his time, experiences more happiness than any one can realise. In this spirit I thank you from the bottom of my heart for the great honour of which you have found me worthy. I should have wished to come to you in person to receive the gold medal, but unfortunately it is impossible for me to do so"

IT is announced by the Foreign Office that Dr. Hu Shih, Dr. V. K Ting, and Dr. C C Wang have accepted the invitation of Sir Austen Chamberlain to serve as Chinese members of the committee which is to advise the Foreign Secretary as to the utilisation of the funds of the Boxer Indemnity Two of these appointments are in accordance with a provision of the China Indemnity Application Act that at least two members of the advisory committee shall be Chinese; the third fills a vacancy created by the death of Sir John Jordan, and follows a decision that it was desirable to increase the Chinese membership Each of the three newly appointed members has had a distinguished career. Dr. Hu Shih, now professor of philosophy and English at Peking, was educated at Cornell and Columbia; Dr. V K. Ting, who is general manager of the Peipiao Coal Mining Co. and honorary director of the Chinese Geological Survey, studied at Cambridge, Glasgow, and Freiburg; while Dr. Wang, after graduating at Yale as a civil engineer, became closely associated with Chinese railway development and administration and has interested himself in various philanthropic and social movements.

THE announcement of these additions to the membership of the advisory committee should go some way towards reassuring Chinese opinion as to the *bona fides* and goodwill of the British people. The reasons for the continued hostility and distrust of the Chinese towards 'foreigners,' particularly as represented by the British, are temperately set forth by Mr. Frederic Anson in the February issue of the *Fortnightly Review* in an article entitled "The Chinese Point of View." Mr. Anson points out that this intense suspicion of everything foreign is due to the fact that a tranquil and exclusive nation has had forced on it from without a western organisation which has made its influence felt, not only in the Treaty Ports, but also in every province, and that owing to the principle of extra-territoriality, this influence is entirely beyond Chinese control. This principle has been, and is, applied rigidly without adaptation or flexibility as China shows signs of development and progress. Further, the students sent abroad to study western civilisation, on their return, finding no prospect in native enterprises, turn to business openings under foreign management; but they find themselves handicapped as against foreigners, often their inferiors in capacity; while they are entirely debarred from social intercourse owing to racial prejudice. It is, therefore, scarcely remarkable that the Chinese regard the foreigner as mainly aiming at exploitation pure and simple. Mr. Anson's article as a whole enforces the need for such a sympathetic understanding of Chinese character and culture in those who have dealings with them as can only result from close study from what, for lack of a better term, can only be called the anthropological point of view.

A PROVISIONAL committee has been appointed to draft the constitution of a society within the University of London for promoting interest in the welfare of animals, Capt. C. W. Hume, of Birkbeck College, being appointed secretary. This step was taken at a meeting held at Birkbeck College on February 12, after a lecture by Capt Fergus MacCunn, assistant secretary of the Royal Society for the Prevention of Cruelty to Animals. The lecturer stated that while a certain amount of prosecution is unfortunately unavoidable at present, some 4000 persons being convicted annually of the grosser forms of cruelty, infinitely more reliance is placed on the educational weapon, and in order to improve its efficiency the advice and co-operation of the educational profession is earnestly desired by the Society. Should the present movement become established in the University of London, efforts will be made to extend it to other centres of learning. Interesting features of the Society's work to which reference was made included (*a*) the holding of prize essay competitions, for which nearly 1,000,000 children compete annually; (*b*) the horse purchase scheme, whereby the services of a veterinary surgeon are provided free of charge to any ex-service man who requires to buy a horse; (*c*) the offer of a prize of 200*l*. for the design of a humane rabbit trap, no really satisfactory design having yet appeared; and (*d*) the humane destruction, at one centre alone, of nearly 60,000 stray cats and dogs, many of which might have proved a source of danger to human health.

IN his discourse delivered at the Royal Institution on February 12 on "Red and Blue Colouring Matters of Flowers," Prof. R Robinson said that the work of Willstatter showed that the anthocyanin pigments of flowers, fruits, and blossoms are substances which form differently coloured salts with acids and with bases. Thus many different shades may be produced by variations of the acidity or alkalinity of the cell-sap alone The molecules of all the anthocyan pigments contain the same fundamental nucleus (with 15 carbon atoms), distributed round which various atomic groupings may be attached in eleven different positions A sugar always occupies one of these positions and may be detached by the action of boiling aqueous acid. The pigment, transformed by loss of its combined sugar, retains its original colour and is now called an anthocyanidin All the known anthocyanins can be ultimately degraded to one of three fundamental anthocyanidins, all of which have been prepared artificially The Indians of Central America in the vicinity of the Orinoco prepare a red pigment called 'carajura' or 'chica' from a species of bushrope. This contains the characteristic nucleus of the anthocyanidins, so apparently carajura proclaims a fourth anthocyanidin. The pigments of flowers are of very little interest to the dyer, since the colours are evanescent Nevertheless, many of the most beautiful of artificial colouring matters, for example, the unsurpassed rhodamines, possess very similar central, tinctorial molecular groupings

ACCORDING to an announcement which appeared in the *Times* of February 15, Mr. John D Rockefeller, Jr, has offered to King Fuad and the Egyptian people the sum of 10,000,000 dollars (2,000,000*l*.) for the purpose of building and maintaining a new museum in Cairo and, in conjunction with it, an archæological institute to be housed in a separate building The offer was recently conveyed to King Fuad by Prof. James H. Breasted, the well-known Egyptologist of the University of Chicago, who has been appointed by Mr. Rockefeller to act as a member of the Board of Trustees of the Fund, of which the other members are Mr Everit Macy and Mr. Raymond B. Fosdick, both of New York It is intended that the new museum and institute should work in co-operation with the Egyptian Service des Antiquités. Details of the arrangements of the offer are to be discussed by representatives of the Egyptian Government and of Mr. Rockefeller at an early date This munificent gift, which is said to be the largest amount ever offered in a single sum for the promotion of humanistic studies, will be of inestimable value both to the investigation of Egyptian culture and civilisation and to archæology at large It has long been impossible to display the mass of material which has been gathered from the various excavations in Egypt in a manner adequate to the needs of students. The increase in space in a museum fully equipped on modern lines with material for the preservation of specimens, and adequately staffed with trained officers working in conjunction with the neighbouring archæological institute, will provide a stimulus to research of which the effect is difficult to estimate fully on this first announcement.

THE sessional programme for 1925–26 of the Institut d'Ethnologie and the Facultés et Établissements publics d'Enseignement supérieur of the University of Paris makes liberal provision for courses of instruction in the various branches of ethnology with special reference to the French colonial possessions. At the Institut, descriptive ethnography and descriptive linguistics are covered by M Marcel Mauss and M. Marcel Cohen respectively. M. M Delafosse lectures on the linguistics and ethnography of Africa, and M Jean Przyluski on the ethnography and linguistics of Eastern Asia and Oceania. Among the lectures to be given under the Faculties of the University are courses on the races of the French colonies by Dr. R. Verneau, the customs of Madagascar by M. Julien, the customs of French West Africa by M Delafosse, moral, religious and family rites in Australia and in the Sudan and Nigeria by M. Mauss, Indo-Chinese religions by M. Przyluski, and on the social, family and religious organisation of the Moslems by Prof. Doutté, Mahommedan law being also covered in a course by Prof. Morand. In sociology a general course is given by M. Fauconnet, and Prof. Cabaton will deal with the geography, history and institutions of Indo-China M. Brunhes, in the department of human geography, deals with "The Problem of the Pacific." In linguistics, provision is made for instruction in the languages of practically all the native populations of the French possessions, including Arabic, Berber, the Sudanese languages, modern Indian, Malagasy, Malay, Siamese, Annamese and Cambodian.

THE fifth annual report of the British Electrical and Allied Industries Research Association, which was presented at the annual meeting of the Association on February 12, is instructive and interesting The period covered was the end of the five years' agreement with the Department of Scientific and Industrial Research As the grants guaranteed by the Department are now on a diminishing scale, the Association has to look to other sources for enlarged contributions. The minimum requirements for the year are 16,000*l*, of which the Department pays 8000*l*., but five years ahead it will only pay 1600*l*. There are a very large number of committees, and representatives of all the interests concerned are present at the meetings. The Department appointed a committee to examine the work in progress, which has reported favourably. In particular it commended the work done on the phenomena of switching, arcing, and insulation. Although it was thought that the Association should not build a laboratory of its own in which to carry out all the investigations, yet in the opinion of the committee it might usefully supplement existing facilities, like the National Physical Laboratory, by the provision of a small laboratory for preliminary researches. The Association acts as a clearing-house for problems of common interest to the whole industry. It is also a great stimulus to the application of scientific methods in commerce. It has to be remembered, however, that an association of this kind does not obviate the necessity of research in pure science. It should and does act as an incentive to individual research. It is this latter kind of research which is in the greatest need of encouragement. We are glad to read that Prof. H. L. Callendar has extended his steam turbine researches to cover temperatures and pressures of 850° F. and 1500 lb. per sq. in. respectively, novel methods having been invented to cope with the experimental difficulties. Mr. Ll. B. Atkinson has been re-elected chairman of the Association, and at the luncheon which followed the annual meeting, he gave an inspiring address on British contributions to the world's progress in science and invention.

IN a paper by G. H. Farnes published in the *Wireless Engineer* for February, some remarkable phenomena observed in high-powered transmitting radio stations are described. In a large commercial station during alterations to the room housing the aerial inductance, it was found necessary to erect a temporary wooden wall. One day this became damp and consequently was slightly conducting. The high frequency currents induced in it by the currents in the coil caused it to heat up and ultimately burst into flame. On another occasion, three damp planks formed a triangle and the heating due to the eddy currents quickly set them on fire. The iron lock on the door is often unbearably hot due partly to hysteresis. A watch worn in the neighbourhood of the aerial is put out of order owing probably to magnetisation of the hair spring. This often happens in the neighbourhood of a dynamo When the point of a pencil is held near a metallic object like the case of an instrument, a torrent of sparks sometimes ensues. On one occasion when two people in the room shook hands, a stream of sparks came from one hand to the other. Out-of-doors the large porcelain strain insulators are sometimes found practically molten inside A portion of the barbed wire fence round the aerial site becomes so hot by the induced current that it cannot be touched, and sparks can be drawn from it by holding a piece of metal near it. A stay wire has been found red hot owing to the induced eddy currents. The top of a 460-foot high wooden lattice mast caught fire owing to sparking. As it cost 5000*l*., and if allowed to burn would close down the station, two firemen climbed up the mast by means of the diagonal bracing members and cut away the burning portions with their axes. Since Hertz's time these phenomena have often been observed on a small scale. We now have to guard against them in commercial undertakings

THE library co-operation movement initiated by the Association of University Teachers has gained momentum and made satisfactory progress during the past year. A large and steadily growing number of libraries of a university, learned, or specialist character in all parts of the British Isles have accepted, though in a few cases with reservations, the inter-library lending proposals put forward, and the increased facilities for research thus secured have already proved useful to investigators in many fields. The Joint Standing Committee on Library Co-operation appointed at last year's Conference has provided for as full as possible a utilisation of these facilities by setting up an Inquiry Office (located for the present in the University of Birmingham) which endeavours to discover copies of any publications required by research workers, and, if successful, reports whether they would be lent temporarily to the inquirer's library on the application of the librarian. Thanks mainly to the generosity of the Carnegie United Kingdom Trust, this information, though usually involving considerable clerical and postal expenses, can be supplied free of charge. There has been a steady increase in the stream of inquiries, and up to the present about seventy per cent. of the publications inquired for, though nearly all rare or foreign, have been reported as obtainable on loan from one or more British or Continental libraries. The compilation of a list of periodicals not included in the recently issued "World List of Scientific Periodicals" has also been begun. Though confined at present to periodicals in the possession of British libraries, and intended primarily to facilitate the work of the Inquiry Office, this list may eventually prove to have a wider usefulness. If published it would prove a valuable supplement to the existing World List.

To a series of articles in the *Forum* on the food resources of the world in relation to future wars, Mr. V. Stefansson contributes to the January issue a paper on Polar pastures. He estimates that of the 3,000,000,000 acres of land in the northern hemisphere that lie north of the region of possible wheat cultivation, the greater part is grazing land which is suitable for the reindeer and musk-ox or ovibos. He points to the successful breeding of the reindeer in Alaska, where, since the introduction of domesticated deer from Siberia between 1892 and 1902, the herds have been doubling every three years. The raising of musk-ox in reindeer lands would be practicable because the reindeer feeds on lichens in winter and uses grass only in summer, while the musk-ox eats grass all the year round. In the Arctic tundras the number of reindeer is limited by the winter food, which is only about one-tenth of the summer supply. This leaves scope for large herds of musk-ox. A use of the musk-ox in addition to the supply of meat would be for the production of fine wool, which has been proved to have the qualities of good merino. In addition it does not shrink. Mr. Stefansson estimates that the Arctic grasslands could support a hundred million reindeer and five times as many musk-ox with a total annual meat production of 55,000,000,000 pounds of meat

ACCORDING to the *News Bulletin of the U.S.S.R. Society of Cultural Relations*, a number of expeditions have been organised by the Russian Academy of Sciences and other scientific institutions, with the object of exploring the regions lying beyond the Polar circle in European and Asiatic Russia One of these expeditions was engaged in explorations of the northern section of the Ural Mountains, previously considered to be impassable. Rare specimens of plants and animals were collected. There were also indications of platinum deposits and petroleum in this region, and surface coal was found in the valley of the river Pechora. The polar expedition of the Academy has made a geological and geographical investigation of Novaya Zemlya Topographical charts were made for the first time in the central part of the Northern Island. The expedition discovered three uncharted lakes, and three new bays on the eastern part of the islands. Preparations are being made for an expedition to the Nicholas II. Land, discovered by Vilkinsky in 1913. This territory has hitherto remained entirely unexplored. An expedition under Prof. Gorodkov is exploring the tundra region between the estuaries of the rivers Ob and Yenisei. A commission sent to the Yakutsk territory for the purpose of ascertaining the amount of arable land available for colonisation found large tracts suitable for agriculture along the rivers Lena and Amga.

THE first number of a new Russian periodical, *Journal de Biologie et de Médecine expérimentales*, published by the State Scientific Institute of the Commissariat of Public Health in Moscow, has just been issued. The journal, which is of the type of *Pfluger's Archiv* and the *Zeitschrift fur die gesamte experimentelle Medizin*, is devoted to experimental works in physiology, general pathology, bio-chemistry, bio-physics, microbiology and allied sciences. The editorial committee, under the directorship of Prof. B. Sbarsky, consists of the following: A. Bach, P. Diatropoff, N. Koltzoff, P. Lazareff, L. Tarassevitch and M. Schaternikoff, with Prof. I. P. Pavlov as one of the chief collaborators. The main object of the journal is to unite in one publication the original works appearing in Russia and hitherto scattered amongst the special biological and medical periodicals, which appeared very irregularly and were frequently inaccessible to workers in allied branches of science. From the editorial notice it is seen that the new journal will appear in 8-9 fascicules per annum, the regular publication of which is apparently ensured. All the papers will be provided with summaries in English, French or German. The first number of the *Journal de Biologie et de Médicine expérimentales* contains nine papers dealing with various questions of immunology, bio-chemistry, bio-physics, experimental pathology, physiology, bacteriology and comparative psychology.

IF the present vogue for noticing centenaries does nothing more than to lead to inquiries into the history of industries, it will have served a good purpose. In mechanical engineering a century ago, Matthew Murray of Leeds occupied a prominent position. Few details of his life are at present available, but the centenary of his death is sure to lead to additions being made to these. He was born in 1765 and died near Leeds on February 20, 1826. He had then been in business with two partners as a steam-engine builder for thirty years, and his firm in 1812 built the four locomotives for Blenkinsop which were the first commercially successful engines of this type. George Stephenson did not construct his first engine until 1814. Murray is also known among engineers as the inventor of the locomotive slide valve, as a pioneer in the use of machine tools, as one of the advocates of steam navigation, and also as a keen rival of the famous old firm of Boulton and Watt.

IT is announced in *Science* that the Nichols Medal in chemistry for 1925 has been awarded by the New York Section of the American Chemical Society to Dr. Samuel Colville Lind, associate director of the U.S. Fixed Nitrogen Research Laboratory, Washington, for his work on "The Chemical Activation of Alpha Particles."

THE following officers of the Royal Astronomical Society were elected at the annual general meeting on February 12: *President*, Dr. J. H. Jeans; *Vice-Presidents*, Dr J. L. E. Dreyer, Sir Frank Dyson, Dr. J. W. L. Glaisher, and Rev. T. E. R. Phillips; *Treasurer*, Lieut.-Col. F. J. M. Stratton; *Secretaries*, Dr. Jackson, Royal Observatory, Greenwich, London, S.E.10, and Mr. H. Knox-Shaw, Radcliffe Observatory, Oxford.

AT the annual general meeting of the Optical Society, held at the Imperial College of Science on February 11, the following officers for the session 1926–1927 were appointed: *President*, Mr. T. Smith; *Vice-Presidents*, Inst.-Comdr. T. Y Baker, Mr. F. F. S. Bryson, Dr. R. S. Clay, Mr. H. H. Emsley; *Treasurer*, Major E. O. Henrici; *Secretaries*, Prof. Alan Pollard, Imperial College of Science, South Kensington, S.W.7, Mr. F. F. S. Bryson, 12 Oppidans Road, N.W.3.

BY the will of the Right Hon. Stephen Ronan, lately Lord Justice of Appeal in Ireland, who died on October 3 last, and left personal estate in England and the Irish Free State valued for probate at 83,907*l.*, the Medical Research Council will receive considerable benefits. After private bequests amounting to nearly 9000*l.* and numerous legacies to Irish charities, the residue is left to the Medical Research Council to be applied in assisting and promoting scientific research as the Council may think best, "but without limiting their discretion, I would wish that special attention should be given to the relief, cure, and prevention of physical pain by physical means."

THE following awards of the Institution of Petroleum Technologists have been announced: The Boverton Redwood Medal for sessions 1923–24 and 1924–25 to Mr. C. H. McCarthy-Jones, for his paper entitled "Electricity applied to the Winning of Crude Petroleum, with Special Reference to the Yenangyaung Field, Burma"; the Students' Medal and Prize for 1925 to Mr. Ernest Clark, Royal School of Mines, Imperial College of Science and Technology, for his paper entitled "Organic Theories of Oil Origin." The Institution's Scholarships for 1925 have been awarded as follows: Royal School of Mines, Imperial College of Science and Technology, London, Mr. J. O. Tanner; University of Birmingham, Mr C. J. Ward.

DR. HEM SINGH PRUTHI, in his letter on "Moulting of Insects" in NATURE of December 26, 1925, p. 938, recorded some experiments carried out on the common mealworm (*Tenebrio molitor*) which afford further evidence that moulting is not necessarily correlated with growth. Mr. C. Macnamara, Arnprior, Ontario, Canada, writes pointing out that Folsom and Welles in 1906, working on the Collembola, concluded that moulting is connected with excretion. The suggestion that the moulting of insects has other functions than providing for growth is recorded in the standard works on insects.

THE "Lopulco" system of powdered fuel firing is making progress in Great Britain. The North Metropolitan Electric Supply Co. will have shortly its new station at Brimsdown working on this system. There are five boilers, each of which has a heating surface of 11,000 square feet. The equipment includes the latest design of pulverising mills each of 15 tons per hour capacity, the making of which, together with the feeders, bunkers, separators, water screens, exhausters, etc., provides employment to many workmen at Barrow and Derby, where the Lopulco works are situated. Capt. Donaldson, the electrical engineer, is satisfied that the system will assure him high thermal efficiency with minimum maintenance and operating charges even from the lowest grades of fuel. As this station when complete will be the largest in the London area operating entirely with pulverised fuel, engineers are awaiting the results with much interest.

WITH the December issue, the *Journal of the Franklin Institute* completes one hundred years of uninterrupted publication, during which it has come to occupy an important position as an organ of the scientific world. Its purpose, that "of reporting to the community the activities of the Institute, and of disseminating knowledge of science and the arts," has enabled it to serve a wide range of readers. Commenting on the increasing specialisation of modern research, which has of necessity been reflected in the pages of the journal, the editors refer to the importance of communicating the multitudinous results obtained by scientific workers in justification of the step they are taking in making the journal the agency for the publication of researches carried out at the Bartol Research Foundation. Thus even more than formerly, the *Journal of the Franklin Institute* will be an organ for the publication of research, though its traditional regard for invention and matters of wide interest in science will be maintained.

APPLICATIONS are invited for the following appointments, on or before the date mentioned:—An assistant lecturer in zoology in the University of Birmingham—The Secretary (March 1). A laboratory assistant in the physics department of the Liverpool Collegiate School for Boys—Director of Education, 14 Sir Thomas Street, Liverpool. A science mistress at the County School for Girls, Gravesend—The Head Mistress.

Our Astronomical Column.

RECENT SUNSPOT ACTIVITY.—The first half of February has offered only very occasional opportunities for observing the sun. A photograph taken on February 5 showed the disc comparatively free from spots, but another taken on February 13 recorded nine or ten groups, including one visible to the naked eye. This spot is the chief of a procession of spots of recent origin, extending for nearly 25° of solar longitude. Details of it are as follows:

No.	Date on Disc, 1926.	Central Meridian Passage.	Latitude.	Area.
3	Feb. 9-21	Feb. 15·0	18° S.	1/1200

(Area expresses the proportion covered of the sun's hemisphere.)

One of the other spots elsewhere on the disc is the large recurring spot, in latitude 21° S., seen previously on the central meridian on December 25 and January 22. It is of regular outline and of about half its original size.

The great spot No. 2 (NATURE, January 30) has returned to the sun's visible disc, but is so much diminished that it is a telescopic object only.

COMETS.—An observation of Blathwayt's Comet was obtained on Feb. 8 by M. Chofardet at Besançon, which led to the following corrected elements:

T 1926, Jan. 3·12 U.T.
ω 328° 30′
Ω 136 5
i 128 22
log q 0·1293

EPHEMERIS FOR 0h.

	R.A.	N. Decl.		R.A.	N. Decl.
Feb. 20	6h 56m 9s	36° 36′	Mar. 4	5h 53m 14s	42° 55′
„ 24	6 29 18	39 36	„ 8	5 41 24	43 50
„ 28	6 8 52	41 33	„ 12	5 32 35	44 30

The comet has now passed its nearest point to the earth and may be expected to fade rapidly; but it is well placed for observation.

EPHEMERIS OF ENSOR'S COMET FOR 0h.

	R.A.	Decl.		R.A.	N. Decl.
Feb. 20	20h 51m 48s	3° 53′ S	Mar. 4	21h 2m 48s	21° 4′
„ 24	20 52 0	3 47 N	„ 8	21 13 24	30 35
„ 28	20 55 42	12 5 N	„ 12	21 28 12	40 14

A HOMERIC ECLIPSE.—The suggestion has been made many times that the passage in the 20th book of the Odyssey, where the seer Theoclymenus describes the sudden gloom and the disappearance of the sun, seems to indicate a total solar eclipse. But until now no one has considered it worth while to carry the matter further.

Dr. C. Schoch, in the *Observatory* for January, describes a research he has made, using Oppolzer's "Syzygien-tafeln" corrected by his own and Dr. Fotheringham's researches on ancient eclipses and occultations. He has examined all the eclipses of the twelfth century B.C., and finds that the only one total in Ithaca was that of April 16, 1178 B.C., total there at 11h 41m A.M. local time. This is five years earlier than the traditional date of the return of Odysseus, a very small discordance. The deduced date of the siege of Troy is 1198 to 1188 B.C. It would be unsafe to lay any great stress on this eclipse, since the poem is much later than the event; but it is extremely interesting to find that calculation supports the narrative, which makes it likely that the tradition used by Homer was not wholly mythical but had a substratum of fact. Dr. Schoch gives the dates in astronomical reckoning, but they are corrected here into civil reckoning.

Research Items.

Maori Agriculture.—Mr. Elsdon Best's valuable study of Maori cultivated plants and native methods of agriculture and attendant rituals and ceremonies has been published as *Dominion Museum Bulletin* No. 9 (Wellington, N.Z.). The Maori appear to have introduced at least five (and possibly six) food plants into New Zealand. These were not introduced by the first settlers; and it was the lack of the food plants of their earlier home as well as the greater difficulty in cultivating those which they did succeed in acclimatising that led them to the utilisation of the so-called fern-root, and exalted it to such an important position in their food supply that it was assigned a special mythical origin. Their principal food plant, however, was the *kumara* or sweet potato Special ceremonials were attached to every stage of its cultivation from planting to harvest Some of these, such as the ritual observed when a tuber of special size was found, recall the corn goddess customs of other countries A tradition, it is conjectured largely on philological grounds, suggests that the Polynesians may at one time have inhabited a country in which rice was the staple diet It is a curious fact that there is a double tradition of the origin of the *kumara*, one associating it with the deity Rongi, the other with the goddess Pani, who brought forth sweet potatoes *in the water*. In other elements in the Pani traditions, *kumara* is also connected with water, although it is a dry land plant. A transference of a rice tradition therefore appears not impossible.

Archæology of the Aleutian Islands.—A valuable monograph on the Aleutian Islands by Waldemar Jochelson has been published by the Carnegie Institution of Washington. It embodies the results of the archæological investigations on these Islands of the Riaboushinsky Expedition of 1909–10, on which the author was the leader of the anthropological section. The object of these investigations was to supplement the results of the Jesup Expedition of 1902 and endeavour to clear up the question of the ethnological affinities and origin of the Aleutians, upon which various views, none of them entirely satisfactory, were held. The anthropological division excavated a number of kitchen middens and house sites, finding many skeletal remains (about fifty were in a sufficiently good state of preservation to be available for measurement), and a large quantity of implements, in stone and bone, utensils, etc. Both geological and cultural conditions appear to preclude the hypothesis that the Aleutians represent a migration from the Asiatic continent. Their boats at the present day are not such as could have faced the lengthy and difficult sea voyage to which the geological conditions point. On the other hand, their language presents close affinities with that of the Eskimo. Their culture, which at the time they were first visited by the Russians still belonged to the Neolithic stage, contains some elements which are to be attributed to their environment, but with certain variations presents a close resemblance to that of the Eskimo; but it also includes elements which are related to the culture of the north-west coast of America Cranial measurements of the dead and living alike show a very high degree of brachycephaly —average 84, which suggests an Athapascan strain. The conclusion is that on the whole the evidence points to the Islands having been peopled from the American rather than the Asiatic continent.

A Mistaken Attribution in South American Linguistics.—We owe to the researches of Dr. Paul Rivet the correction of a mistake in American linguistics which has endured for nearly seventy years. In 1858 Ludewig in his "Study of American Aboriginal Languages" referred to a text in the Arda language which had been printed at Madrid in 1658. No ethnographical data are available relating to the Arda tribe, and the only fact known concerning it is that it lived between the upper waters of the Nanay, a tributary of the Amazon, and the Mazan, a tributary of the Napo. It was surrounded by the Yameo people on three sides and bounded on the north by the Zaparo tribe Dr. Rivet, who had devoted attention to this text, of which a copy is in the Library of San Isidro at Madrid, at intervals over a period of years, at last became suspicious as to its provenance, and submitted it to M. Maurice Delafosse, the well-known African authority. The result of M. Delafosse's examination is given by Dr. Rivet in the *Proceedings* of the twenty-first International Congress of Americanists held at Göteborg in 1924. The verdict is that the text in question is in pure Dahomean, and, except for a few phonetic variations possibly due to transcription, might well be contemporary. Portions of the text and the modern language printed in parallel columns place this conclusion beyond question. Further study has revealed that it belongs to the Popo dialect, and it is interesting to note that in date it is a hundred years earlier than any hitherto known specimen of the language of this part of Africa. It is clear, therefore, that the language of the Arda tribe can no longer be regarded as independent, as has been done on the evidence of this document; and the statement of Velasco that it belongs to the extinct dialects of Yameo, which had been abandoned as incorrect, must be reinstated.

Two Additions to the British Avifauna —In two recent issues of the *Scottish Naturalist*, Admiral J. H. Stenhouse describes two species of birds recorded for the first time from Britain Both arrived at Fair Isle, between the Orkney and Shetland Isles, during the autumn migration season of 1925, and this in spite of the fact that, during the period of the recorder's visit, weather favouring prolonged east to west migration was absent. The Petchora pipit, ***Anthus gustavi*** (Fair Isle, September 24), breeds in N.E. Russia and widely across northern Asia to Kamchatka, whence it generally moves south-east to China during the winter. It has not before been noted in Europe beyond Russia. Jerdon's reed-warbler, ***Acrocephalus agricola*** (Fair Isle, October 1), is a more southern bird, breeding in the Ural region and across Asia to the Himalayas. In winter it is found in India and north-west Africa. Apart from one record from Heligoland, it has not previously been found in western Europe. Both birds were far out of the normal migration track of their species.

The Medusæ of Norway —Dr. P. L. Kramp and Prof. D. Damas have published (*Vidensk. Medd. fra Dansk. naturh. Foren.*, Bd. 80, 1925) an account of the medusæ of Norway. The specimens on which the account is based have been collected from 1900 onwards, chiefly during cruises of the *Michael Sars* When the cruises of this vessel began, there were known with certainty only 17 species of medusæ in Norwegian waters, to which 10 were afterwards added through the work of E. T. Browne, and 7 more by Hj. Broch It was realised that with such an extended coast-line and numerous islands with deep water adjacent, providing a great variety of conditions, careful investigation would probably result in a considerable addition to the list of species; and so it has proved, for 57 species are now known, 19 of which are recorded from the area for the first time. The present account deals with the Hydrozoa—the Scyphozoa being reserved for a future part. Under each species is given a list of the stations at which examples were collected, notes on systematic characters, and in many cases on the geographical and bathymetrical distribution. Excellent figures are given of the new genus and of two new species, of some of the rarer species, and of aberrant examples.

Herring.—Mr. W. C. Hodgson gives us his second report on the work he has done in connexion with the herrings of the southern North Sea (Ministry of Agriculture and Fisheries, Fish Invest., Ser. ii. Vol. 8, No. 5, 1925. 6*s.* 6*d.*) From samples taken by the *George Bligh* and from records previously published by Bjerkan, immature herrings with one winter ring on their scales may be taken about the Dogger Bank, the Firth of Forth, and the Skagerak. Fish in their third year make their appearance in the commercial shoals, but, whilst some of these may become mature, it is not until the fish are a year older that they form the greater part of the catches made off the north-east coast, Northumberland to the Spurn, and high numbers come to maturity. With this and the statement that the younger fish are followed by older fish into the great fishery of the Southern Bight, and the finding of a considerable amount of spawning now on these grounds, Mr. Hodgson confirms a great deal of evidence which has been accumulated and interpreted by other workers. The presence in the shoals off the Northumberland coast in 1923 of large numbers of herrings with three growth zones on their scales and having a small first-year growth may be regarded as exceptional, and so may be the high percentage of fish of this age found in the catches from north-east of the Spurn in 1924. Negative evidence has been found for a migration of spents into the Channel from the Southern Bight, but a sample from north-west of Skagen indicates the possibility of a movement towards the Skagerak. The mixing of mature fish with first-year growths of 8 cm. and 9-11 cm. inclines Mr. Hodgson to agree with Storrow as to the impossibility of the occurrence of separate races of herring in the North Sea, so far as the southern half is concerned.

The Hyomandibula of Fishes.—In an important paper on this subject (*Jour. Anat.* 60, pp. 173-93, January 1926) Prof. F. H. Edgeworth, as an adherent to the theory of Gegenbaur that the hyomandibula in the Teleostomi is homologous with that in the Selachii, reviews the recent theories of Allis, Schmalhausen, and de Beer and, after critical examination, rejects them in favour of the Gegenbaur hypothesis. In support of this view he advances the following facts: (1) In both groups of fishes the hyoid bar is at first a continuous one, its upper end at first not reaching the auditory capsule, though afterwards doing so; (2) the hyomandibular is the segmented-off upper part of this bar; (3) it comes into relationship with the auditory capsule in both groups; (4) the relations of that portion of the hyoid constrictor muscle which forms a levator hyomandibulæ are similar in the Chondrostei and Selachii. The curious condition found in Ceratodus he concludes is almost certainly secondary.

Pelvic and Thigh Muscles in Ornithorhynchus.—Miss Helga S. Pearson (*Jour. Anat.* 60, pp. 152-63, January 1926) has made a detailed study of these muscles in Ornithorhynchus with the view of interpreting their homologies in the light of recent work on the homologies of the muscles of the Vertebrata based on a study of fossil forms, especially the work of Romer on the locomotor apparatus of amphibia, reptiles, and mammals. Romer had not dissected any monotreme himself, but relied on earlier descriptions for the conditions obtaining in this group. Miss Pearson's work, therefore, supplements Romer's in this respect. She rejects the views of the earlier workers, especially Westerling, on the homologies of the muscles in this group, and finds that, so far as the pelvic and thigh muscles are concerned, they can be readily brought into line with Romer's ideas. They are essentially mammalian in their arrangement, but sometimes still suggest a reptilian origin. Miss Pearson has carefully described each muscle and indicated its reptilian homologue in Romer's scheme. The paper is well illustrated by a series of carefully constructed and very clear figures.

Artificial Cells.—Year Book No. 24, issued by the Carnegie Institution, Washington, contains brief progress reports on a number of interesting investigations. Under the director, Dr. D. T. MacDougal, the laboratories for plant physiology at Tucson, Arizona, and Carmel, California, continue the attempt to parallel the phenomena of absorption by the plant cell, by the properties exhibited by artificially constructed cells. One definite success is recorded, in that the artificial cell, if agar, pectin, and gelatin are used in appropriate proportions and method in its construction, shows the same sort of anomalous behaviour, in removing potassium ions selectively from solution containing both sodium and potassium ions, as is shown by the living plant cell. Beverly L. Clarke reports upon this investigation, as also upon some interesting experiments on the condition governing the swelling of agar gels.

Antennæ of Trilobites.—Hitherto the antennæ have been found in only four species of trilobites belonging to the genera Neolenus, Triarthrus, Trinucleus, and Calymene, which range in age from Middle Cambrian to Upper Ordovician. In a large collection of trilobites from the Lower Cambrian of Lancaster County, Pennsylvania, which has been received by the Peabody Museum, Yale University, C. O. Dunbar (*American Journ. Sci.* 9, 1925, p. 303) has discovered the antennæ in one specimen of Olenellus. They appear to have been about half as long as the body. The species of Olenellus is regarded as new, but closely resembles *Olenellus Thompsoni*.

Australian Wind Storms.—A discussion on Australian hurricanes and related storms, with an appendix on hurricanes in the South Pacific, prepared by Mr. Stephen S. Fisher of Chicago and Mr. D. Hodge of the Bureau of Meteorology, Melbourne, has been issued under the direction of Mr. H. A. Hunt, Commonwealth Meteorologist (Bull. No. 16, Bureau of Meteorology, Melbourne). The publication has been undertaken that all recorded data regarding the occurrence of hurricanes in Australia and the surrounding tropical waters might be available for the information of mariners and shipping interests generally. In Australia the Queensland coast is most often affected by hurricanes. In the thirty-four years 1890–1923 they averaged one or two a year, coupled annually with two or three storms of less severity. Four-fifths of the storms occur in the five months December to April, and two-thirds of the storms occur in January, February, and March. Most of the hurricanes which affect Queensland come from the east; many recurve near the coast and pass southward, frequently so far as Brisbane. Western Australia has, on the average, rather more than one hurricane a year. In the fifty-two years 1872–1923, 74 severe tropical cyclones were recorded; some years had as many as three, and one year, 1917, had five.

Of the less severe types of storm, Western Australia has fewer than Queensland. The portion of Western Australia which is most often damaged by hurricanes lies far north of Perth. The hurricanes are most frequent in the hotter months. The Northern Territory has fewer cyclones than Queensland or Western Australia. Attempts have been made to issue long-previous predictions of hurricanes but no satisfactory result has been attained. Maps are given showing the hurricane season in different parts of Australia and the movement of the hurricanes at different seasons of the year.

Measurement of Air-flow.—Methods of air-flow measurement are of importance in many industries and in factories where fans are utilised for ventilation. The Pitot-static tube is the instrument most commonly used for accurate determination of air-flow velocity, but little detailed information is available regarding its characteristics. It consists of an open-ended tube facing the wind, with holes situated in a concentric tube aft of the open end. Both openings are normally connected to the ends of a water-gauge and the pressure difference gives a reading proportional to the square of the air-flow velocity. Experience with the National Physical Laboratory standard instrument has shown that, although accurate under certain conditions, it is defective in many respects. Investigations described by Messrs E. Ower and F. C. Johansen (Aeronautical Research Committee, R. and M. 981, "The Design of Pitot-static Tubes" London: H.M. Stationery Office, 1925. Price 9*d.* net) have now indicated that these defects may be eliminated by the following precautions: The static holes in the concentric tube should be at least six diameters back from the base of the head, and the supporting stem at least fifteen diameters downward from the holes. The calibration will then be practically independent of the shape of head used, and therefore insensitive to relatively large variations in the form of the nose, so that considerable latitude in the manufacture of duplicates will be permissible without entailing special calibration. From both aerodynamic and mechanical considerations a hemispherical nose is most suitable. The instrument is then markedly less sensitive than the standard Pitot-static tube to angular deviations of the wind, an important feature.

River Sounding Experiments.—The determination of submerged contours by the process known as sounding has always been subject to the difficulty of ensuring perfect verticality in the sounding chain, or wire. In most cases, the divergence from the perpendicular has not been of serious moment, but it can readily be understood that, in taking measurements in order to compute the discharge of a river in flood, as close an approximation as possible to the actual depth is of the utmost importance. The matter forms the subject of a monograph prepared by Dr. Phillips of the Egyptian Hydrological Service ("An Experiment to Determine Corrections to Sounding in River Gauging," Government Publications Office, Ministry of Finance, Darawin P.O., Cairo, price P.T. 5). He states that the practice at discharge sites in Egypt has been to sound with a heavy conical lead weight of about 48 kgm. suspended by a piano wire of 1·6 mm. diameter. A stay wire is fixed to the weight and pulled, from some point well forward in the boat, until the part of the suspension wire which can be seen above the water is vertical, and it has been assumed, with a certain amount of latitude, that in this position the sounding measured is a true sounding. Dr. Phillips proceeds to describe the experiments he made with the view of ascertaining the correction necessary to be introduced in order to rectify the deviation of the sounding wire caused by the flow of the current. The problem was attacked by suspending the sounding weight from the side of a launch and dragging it through still water at various speeds and with various lengths of sounding wire. By this means the curvature of the sounding wire for the respective speeds and lengths was experimentally determined. After, detailing his experiments and recording the results, Dr. Phillips concludes that the corrections have been established with sufficient accuracy.

New Uses for Metallic Tantalum.—It is stated in the *Chemiker-Zeitung* that Messrs. Siemens, Halske and Co have succeeded in solving the problem of producing pure metallic tantalum in the form of large blocks and sheets of foil, which will be likely to provide most useful material for the manufacture of scientific apparatus. At ordinary temperatures the metal remains untarnished in air, and it resembles the noble metals in its resistance to the attack of chemical reagents In particular, it is said to be unaffected by all acids except hydrofluoric acid. When first prepared by the same firm in 1903 it was used for making the filaments of incandescent electric lamps, but for this purpose it has been superseded by tungsten, which melts at a higher temperature. It is claimed, however, that it is still superior to all other metals for the manufacture of the electrodes of high-vacuum tubes, and it has also been used extensively for making small surgical and dental instruments. Basins of platinum may now be replaced by basins of tantalum, since the latter metal resists chemical action satisfactorily, and it can also be heated to redness for long periods without deterioration. Moreover, it is claimed that electrodes of tantalum are superior to platinum electrodes in the electrolysis of metallic salts. Thus in the electrolysis of common salt the electrodes are not attacked; in the case of zinc salts the cathode forms no alloy with the zinc, so that no coating with copper or silver is necessary. When used as anodes, the metal usually protects itself from attack with a layer of oxide. By means of the new process the firm has been able to reduce the cost of the metal to about one-twelfth of that of a similar *weight* of platinum.

Separation of the Isotopes of Chlorine.—Further experiments on the separation of the isotopes of chlorine by diffusion and the determination of the atomic weight of the light fraction are described by W. D. Harkins and F A Jenkins in the January number of the *Journal of the American Chemical Society* It will be remembered that previous experiments reported in Nature dealt with the heavier fraction, and that chlorine of atomic weight 35·515, about 0·058 higher than ordinary chlorine, was obtained by diffusion methods. The present paper deals with the results of a series of diffusions of hydrogen chloride through the stems of Scotch clay churchwarden pipes at atmospheric pressure. The aim was to produce chlorine of atomic weight lower than that of ordinary chlorine, and in the final product the atomic weight was found to be 35·418, or 0·039 less than that of ordinary chlorine The extreme separation of chlorine into light and heavy fractions thus represents a change of atomic weight of 0·097 unit, or 1 part in 365. It is pointed out that this is the greatest relative difference of atomic weight obtained by artificial means for any element The atomic weights were obtained by determining in quartz flasks the ratio of the weights of highly purified silver to extremely pure silver chloride, with no transfer of silver or silver chloride from one vessel to another.

The Kansas City Meeting of the American Association.

THE annual meeting of the American Association for the Advancement of Science was held at Kansas City, Missouri, December 28, 1925–January 2, 1926. This gathering was the eighty-second meeting of the Association. With it met twenty-nine scientific societies. The total registered attendance was 1931. The total number of papers read was 985.

The policy of the American Association differs from that of the British Association in encouraging the reading in sectional meetings of large numbers of communications, especially many by younger scientific workers. In another respect, however, the practice of the British Association was followed to advantage at Kansas City, namely, in that there were a number of evening and afternoon lectures specially arranged for the general public, seven in all. All sessions of sections, and the various society meetings, were open to the public Several radio talks were arranged, and popular accounts of a large number of the papers were prepared for wire and mail service to the daily press by a local publicity committee and by Science Service, of Washington.

The address of the retiring president of the American Association, Dr. J. McKeen Cattell, editor of *Science* and the *Scientific Monthly*, was delivered on the evening of the opening day. Dr. Cattell spoke on "Some Psychological Experiments," emphasising the application of methods of psychological measurement to modern industrial and social problems.

The paper selected by the award committee for the annual 1000 dollar prize of the American Association, as an outstanding contribution to science presented at the meeting, was by Prof. Dayton C. Miller, of the Case School of Applied Science, Cleveland, Ohio, and was entitled "The Michelson-Morley Ether-Drift Experiment, its History and Significance." This paper was read on the Tuesday afternoon, as the presidential address of the American Physical Society.

A paper on a related subject was presented on the following day by Prof James Pierpont, of Yale University. Prof. Pierpont's address was delivered under the auspices of the American Mathematical Society, as the third annual Josiah Willard Gibbs lecture. His title was "A History of Man's Effort to Solve the Problem of Space, and the Effect of Relativity on Our Views."

Two symposia were led by Prof. Michael I. Pupin, president of the Association. The first was held by the Engineering Section on the Wednesday evening, with a discussion of the relation of engineering to the fundamental sciences. On Thursday afternoon the Committee of One Hundred on Scientific Research discussed the problem of the encouragement of research workers and of securing co-operation among them. The same question was attacked by Dr. Vernon Kellogg, secretary of the National Research Council, whose address before the Entomological Society of America was entitled "Co-operation or Isolation in Science?"

President F D Farrell, of Kansas State Agricultural College, chose as the topic of the fourth annual Sigma Xi lecture "The Desert Becomes a Garden," telling how the region between the Missouri River and the Rocky Mountains, once marked on the maps as the "Great American Desert," has become one of the most productive agricultural areas in the world. The whole of Wednesday afternoon was devoted to a symposium on prairie ecology, participated in by the botanical and zoological groups.

The newly elected president of the Association is Dr. Liberty Hyde Bailey, formerly dean and director of the New York State Agricultural College at Cornell University, Ithaca, N Y., well known as the writer and editor of many works on botany and on various aspects of horticulture and agriculture, as well as on rural life in general. Dr. Bailey was also chosen president of the Botanical Society of America

The next annual meeting of the Association will be held in Philadelphia, and later annual meetings are planned for Nashville, Tennessee; New York City; Des Moines, Iowa; Cleveland, Ohio; and New Orleans, in order. This series of meetings will complete the first of the twelve-year cycles contemplated in the plan inaugurated at the Chicago meeting in 1920. According to that plan, the Association is to meet in Chicago, Washington, and New York in rotation once each quadrennium, meetings during the interim years being held in other cities, alternating between larger and smaller places, and between locations in the eastern States and in the west and south.

FRANK THONE.

The Standardisation of Insulin.

THE position which insulin holds in clinical medicine in the treatment of diabetes would never have become so firmly established if the manufacture of the product had not been controlled. The appearance on the market of preparations of varying potency, perhaps even inactive, would have led to a great delay in the recognition of the usefulness of this compound, perhaps even to a certain amount of scepticism as to its actuality. To control production adequately, then, meant the discovery of a method by which the activity of different samples could be accurately compared and expressed in terms of some known standard. The latter was, and is still, defined in terms of the blood-sugar reducing power of insulin, after injection subcutaneously into normal rabbits. Thus one rabbit unit is that amount of insulin which will reduce the blood-sugar of a 2 kilo. rabbit, starved for twenty-four hours, to the convulsive level of 0·045 per cent.: a clinical unit is one-third of this amount and is the unit which is now generally used. The problem of putting on the market samples of insulin of known and unvarying potency has been simplified by the issue, to those manufacturing the product, of a solid powder (the hydrochloride of insulin), the activity of which has been determined by the authorities controlling the manufacture: this standard powder is now in use in different countries, so that all samples produced should be of the same activity. But this, of course, depends upon the accuracy of the assay of the sample against the standard.

Methods of estimating the activity of insulin preparations have been developed utilising both the blood-sugar reducing property and also a secondary result of this property, the production of convulsions on doses which reduce the blood-sugar to levels of 0·045 per cent. or lower. Owing to the fact that the occurrence of convulsions in a group of animals is much less regular than a fall in the blood-sugar after a dose of insulin, to obtain consistent results very large numbers of animals must be used, either rabbits or, perhaps more conveniently, mice. But even utilising the first method, complications arise from the fact that different animals react very differently to the same dose of insulin on the same day, and the same animal shows definite variations to the same dose on different days. A method, therefore, which tends to eliminate such variations increases the accuracy of the assay, the "crossover" test described by H. P. Marks (*Brit. Med. Journ.*, 1925, vol. 2, p. 1102) appears to a great extent to fulfil this condition Rabbits of about 2-3 kilo. in weight are used, those which convulse on one unit per kilo. or are abnormally insensitive having been previously eliminated from the stock. The principle of the method is to divide the rabbits into two groups, of which one is given a dose of standard and the other a dose of the sample, and then to repeat the test a few days later, reversing the doses given to the two groups In this way variations affecting the whole of the rabbits, the bulk daily variations in sensitiveness, are eliminated entirely, or almost entirely, since different rabbits may respond somewhat differently to these bulk variations, moreover, by using a large enough number of animals, it is possible to eliminate to a great extent the individual variations, which may be in the direction of either increased or decreased sensitiveness, since these variations may be supposed to cancel out

The details of the actual test are as follows the rabbits, at least six, preferably twelve or even more, are starved for the twenty-four hours preceding the test On the morning of the test, blood is drawn from an ear vein of each rabbit, and then half are given a dose of standard corresponding to 0·5 unit per kilo. subcutaneously, and the other half a dose of the sample, which is assumed to be of about the same value. Blood is drawn from the ear every hour after the injection for five hours, by which time the blood-sugar has usually returned to its initial level. A little more than 1·0 c.c. of blood is drawn at each bleeding, the blood-sugar being estimated by the Shaffer-Hartmann method. The average value for the blood-sugar over the five hours after the injection is found and subtracted from the initial value the result, expressed as a percentage, is known as the "percentage reduction" of the blood-sugar After at least three days the test is repeated on the same group of rabbits, starved for the preceding twenty-four hours, but the rabbits which previously had a dose of the standard are now given a dose of the sample, and vice versa. The sum of all the percentage reductions on the sample is now compared with the sum of those obtained on the standard, the result being expressed as a percentage of the latter. When the sample has a strength of about 100 per cent compared with the standard, the standard error is about 2·5, trial of the method with known doses of standard tested against 100 per cent. standard showed that the effect produced tended to be closer to the 100 per cent than the actual dose given. thus a dose of standard 110 per cent. against standard 100 per cent. gave a result of 106 per cent, whilst a dose of 80 per cent appeared to be 83 per cent.; moreover, the standard errors with these two doses were 3·7 and 6·3 respectively. From the figures given it is possible to calculate the actual strength of a solution of insulin with a fair degree of accuracy, to make the appropriate change in its strength to bring it to 100 per cent and, on retesting, to feel fairly confident that the result obtained will agree, within about 5 per cent., with the result expected.

Do insulin solutions of somewhat varying potency, assayed in the laboratory on *normal* rabbits, show parallel variations in potency when used clinically on *diabetic* patients? According to G A. Harrison and R D. Lawrence, in a continuation of the same paper (p 1104), this is now the case Although in the early days of insulin testing variations in the activity of different samples of insulin could be detected clinically, and clinical results did not agree always with those obtained in the laboratory, during last year the laboratory tests agreed very closely with the clinical tests, so that the authors conclude that the method of assay above described gives results which are perfectly satisfactory for determining the potency of solutions to be used clinically. In the performance of the clinical tests strict adherence to diet and daily routine is essential the two samples of insulin are given on successive days and the resultant falls in the blood-sugar plotted as superimposed graphs. if the curves show a reasonable coincidence, the samples are considered to be of the same strength; if one appears stronger than the other, the test is repeated later, using doses which are more nearly comparable. It should be emphasised that small differences in the strength of different batches will not be detected clinically unless the patient's whole daily routine is kept absolutely constant. The authors consider that variations of 10 per cent. from the standard will not be inconvenient clinically: as has been seen above, the method of assay worked out by Marks is capable of determining even smaller differences.

The Lines of the Solar Spectrum.

AN important paper by K. Burns and W F. Meggers, dealing with the wave-lengths of lines in the solar spectrum, appears in Vol 6, No. 7, of *Publications of the Allegheny Observatory*. In order to investigate a number of problems connected therewith, the Allegheny Observatory co-operated with the Bureau of Standards, Washington, the observations being made at the former institution and the measurements jointly. The problems dealt with in the present paper are the errors in Rowland's measurements of solar wave-lengths over a limited range of spectrum, and a preliminary study of the relative wave-lengths of lines in the solar and terrestrial spectra. An image of the sun was formed in a Fabry-Perot interferometer by a lens of 40 cm. focal length. The issuing light was focussed by a quartz-fluorite achromatic lens on the slit of a spectrograph containing a Michelson grating having 500 lines per mm. and giving a dispersion of 3 65 Å U. per mm. in the first order. The resulting spectrum therefore appeared as a number of line images of the slit, each crossed by segments of the interference ring system, the centre of which coincided with the centre of the spectrum line. Special attention was given to a disturbing interference effect which disappeared when the slit width was properly adjusted, and the paper contains a useful discussion of the interference phenomena associated with a continuous spectrum

The wave-lengths were measured by comparison with those of standard lines of neon. Light from a neon lamp was reflected through the same apparatus by means of a half-silvered diaphragm placed before the interferometer, and the neon lines, crossed by rings, were photographed in an auxiliary camera of shorter focus. The thickness of the interferometer (ranging, in separate experiments, from 3 75 mm to 10 mm.) was computed from the neon lines, and the solar wave-lengths were thereby calculated. A table gives the wave-lengths of 201 lines in the region λ4754 – λ4073 and the corrections to be applied to

Rowland's values at frequent intervals throughout this region.

In order to compare solar and terrestrial wave-lengths a vacuum iron arc was used, the comparison being made either by simultaneous exposures to sun and arc or by successive exposures and independent comparison with neon. A systematic shift of the solar lines to the red was revealed, which increased with both intensity and wave-length, within the region above quoted. It is stated that the dependence on wave-length might be merely an indirect effect of the dependence on intensity, arising from the difficulty in comparing intensities in different regions of the spectrum. Owing to the need for more extended investigation, no attempt is made to form a judgment concerning the nature of the red shift, but the shift itself and its variation with intensity are regarded as real, and as making it impossible to say at present whether or not the Einstein displacement exists in the solar spectrum.

University and Educational Intelligence.

ABERDEEN.—The University Court has appointed Dr. A. W. Borthwick, senior research officer to the Forestry Commission, to the chair of forestry; and Dr. J. Cruickshank, reader in bacteriology in the university, to the chair of bacteriology. Both are first appointments to recently founded chairs.

Sir David Prain has been appointed to deliver a university lecture in the science faculty.

CAMBRIDGE.—Mr S. Lees, fellow of St. John's College, has been reappointed as Hopkinson lecturer in thermodynamics. Mr. F. Debenham, fellow and tutor of Gonville and Caius College, has been appointed Director of the newly formed Polar Research Institute.

The Pinsent-Darwin Studentship has been allotted to Dr. R. D. Gillespie, of the Cassel Hospital for Functional Nervous Disorders, for the period of three years.

A Scientific Research Fellowship at Girton College of the value of 300*l.* a year is offered for research in mathematical, physical, and natural sciences. Women who are graduates or have taken honours in a final degree examination of any university, and members of the Girton College Roll, are eligible. The appointment will be for three years in the first instance. Applications must reach the Secretary of the College on or before April 12. The proposed course of research, and a dissertation or published work, and other evidence of fitness to undertake the research, are required.

LONDON.—A course of three public lectures on "The Constitution and Evolution of the Stars" will be given by Prof. A. S. Eddington at King's College, at 5.30, on February 22, 24 and March 1. A similar course, on "Some Principles of Therapeutics," will be given at St. Thomas's Hospital Medical School at 5.30, on February 22, 23, and 24, by Prof. D. Murray Lyon. No tickets are required in either case.

Three further courses of free public lectures are announced, namely: "The Morphology of the Vascular Cryptogams in the light of Pre-carboniferous Plants," by Prof. W. H. Lang, at University College, on March 1, 3 and 5, at 5.30; "Active and Passive Immunity," by Dr. R. A. O'Brien, at University College Hospital Medical School, on March 1, 5, 8 and 12, at 5, and "Atomistic Physics," by Prof. A. Sommerfeld, at the Imperial College of Science, on March 3, 9 and 10, at 5.30.

BRITISH Dyestuffs Corporation is again granting facilities to a limited number of university students taking honours schools in chemistry, to enable them to gain an insight into chemical works practice. The students must be of British birth, have no direct connexion with the dyestuffs industry or industries competing with the Corporation, and they must be recommended by their professor of chemistry. Application forms should be returned to the Corporation at 70 Spring Gardens, Manchester, marked "Vacation Course," not later than May 1. If sufficient applications are received, courses are proposed for the periods July 1-28 and September 1-30 only.

THE Ramsay Memorial Fellowship Trustees in their report for 1924–25 give particulars of the eighteen fellowships (including five temporarily vacant) which they are administering. These fellowships are for research in chemistry and are, ordinarily, worth 300*l.* a year for two years. Those awarded in 1924–25 were held at University College, London (5), King's College, London, the Imperial College of Science and Technology, London, Oxford (2), Cambridge (2), Bristol, Manchester, Sheffield, and the Davy-Faraday Laboratories of the Royal Institution, London. Eleven of them were held by fellows from other countries: a Canadian at Cambridge under the direction of Sir Ernest Rutherford, a Dane under Prof. M'Bain at Bristol, a Dutchman under Prof. Robert Robinson at Manchester, a Frenchman under Sir William Bragg at the Royal Institution, a Greek under Prof. E C Williams in the Ramsay Laboratory of Chemical Engineering at University College, London, an Italian at Cambridge under Prof. Lowry, a Japanese and a Spaniard under Prof. F. G Donnan at University College, London, a Norwegian at Sheffield in the Department of Metallurgy, a Swede at King's College, London, under Prof. Richardson, and a Swiss at the Royal School of Mines, Imperial College, under Prof. H. C. H. Carpenter.

THE Commonwealth Fund Fellowships were established a year ago by the Commonwealth Fund of New York, a philanthropic foundation existing since 1918 and supported by gifts from Mrs. Stephen V. Harkness. They are tenable by British graduate students at American universities and are worth about 600*l.* a year for two or, in exceptional cases, three years. A report of the working of the scheme in its first year, issued last November and recently received, shows that every university and university college in Great Britain and Ireland, with one exception, sent in candidates, and that on the final list Cambridge, Durham, Edinburgh, Leeds, London, Manchester, Oxford, Belfast, St. Andrews, and Wales were represented. The chosen subjects of study of the twenty successful candidates are: Agriculture, architecture, botany, chemistry (3), classics, economics (2), English (2), geology (2), history, law, mathematics, medicine (2), and physics (2). The fellowships will be held in the first instance at the following universities Harvard (3), Yale (2), University of California (2), Cornell (2), University of Wisconsin (2), Johns Hopkins (2), University of Chicago (2), Columbia (2), University of Illinois, Princeton, University of Minnesota One of the conditions of tenure is that fellows are required to travel for three months in the United States at the end of the first year. Each fellow is asked to submit by the middle of the academic year a plan for travel in connexion with his work, for example, to visit libraries, laboratories, or universities. Advice regarding the plan is offered by the New York office of the Fund, and letters of introduction when possible, and sufficient allowance is made for comfortable travel.

Contemporary Birthdays.

February 19, 1858.	The Duke of Bedford, K.G., F.R.S.
February 19, 1859.	Prof. S. Arrhenius, For.Mem.R.S.
February 19, 1871.	Dr. W. Diller Matthew, F.R.S.
February 19, 1865.	Sir Sven Anders Hedin, Hon. K.C.I.E.
February 22, 1856.	Prof. M. J. M. Hill, F.R.S.
February 23, 1856.	Viscount Cave, G.C M.G
February 25, 1869.	Prof. Arthur W. Crossley, F.R.S.
February 26, 1864.	Mr. John Evershed, F.R.S.

The DUKE OF BEDFORD, who was born in London, graduated at Balliol College. His Grace is a trustee of the British Museum and president of the Zoological Society of London.

Prof. ARRHENIUS was born at Wijk, near Upsala. He is the originator of the theory of electrolytic dissociation, and was Nobel laureate in 1903. In the previous year he was awarded the Davy medal of the Royal Society for his application of the theory of dissociation to the explanation of chemical phenomena. In 1914 the Chemical Society allotted him its Faraday medal, and Prof. Arrhenius received it in person. On that occasion Sir William Crookes said, "The world is deeply in need of researchers both of the type of those whose genius is characterised by that fertility of resource in experimental investigation exhibited by Faraday and the type of Arrhenius. Both are revolutionaries and founders of new kingdoms. The world's debt to them is incalculable."

Dr. MATTHEW, palæontologist, was born at St. John, New Brunswick. He is curator of fossil vertebrates in the American Museum of Natural History, New York.

Sir SVEN ANDERS HEDIN, explorer and geographer, was born at Stockholm and educated there and in various foreign cities In 1902 he was ennobled by the King of Sweden. He is Hon. D.Sc. (Oxon., Camb.). The Founder's medal of the Royal Geographical Society was awarded him in 1902. Sir Sven published "My Life as an Explorer" in 1925.

Dr. M. J. M. HILL, formerly professor of mathematics in the University of London, was born at Berhampore, Bengal. Educated at Blackheath, University College, London, and Peterhouse, Cambridge, he was 4th wrangler and Smith's prizeman (1879).

Viscount CAVE was born in London. Educated at Merchant Taylors' School, he graduated at St. John's College, Cambridge. Lord Cave is chairman of the Grand Council of the British Empire Cancer Campaign.

Prof. CROSSLEY is a Lancashire man. He went to Mill Hill School, and afterwards he graduated at the University of Manchester. He is also Ph.D. (Wurzburg) Formerly Daniell professor of chemistry in the University of London (King's College), he is now director of the Cotton Industry Research Association, Didsbury. Prof. Crossley is an Officer of the Legion of Honour.

Mr. EVERSHED, until lately director of the Kodaikanal and Madras Observatories, is distinguished for his work in astrophysics. In 1918 he was awarded the gold medal of the Royal Astronomical Society for his investigations of the radial motion in sunspots, and more recently he has detected the shift of the lines of the solar spectrum required by the theory of relativity.

Societies and Academies.

LONDON.

Royal Society, February 11.—H. G. Thornton and N. **Gangulee**: The life-cycle of the nodule organism *Bacillus Radicicola* (Beij) in soil, and its relation to the infection of the host plant. A regular cycle of changes was found, unbanded rods, cocci, and banded rods successively predominating in the soil. Increase in the percentage of cocci was associated with increased bacterial numbers and with the appearance of motile forms. When soil and sand is inoculated with a suspension of the bacteria, the latter commence, after a lag period, to spread radially at an approximate rate of 1 inch in 24 hours. The lag is apparently related to the time taken for cocci to predominate in the soil, and is decreased by using milk and 0·1 per cent. of calcium phosphate as the inoculating fluid. The bacteria multiply rapidly in the soil into which they have recently spread. Lucerne plants grown from seed inoculated with a suspension of bacteria in milk + 0·1 per cent. calcium phosphate showed a considerable increase in nodule numbers and in yield compared with plants from seed inoculated with a suspension in milk alone.—C. E. **Walker**: The meiotic phase in certain mammals. The daughter chromosomes of the last somatic division before the first meiotic split longitudinally. The semivalent half-chromosomes lengthen out, until the whole nucleus is filled with fine semivalent threads. This is the end of the telophase. These semivalent threads join together again in pairs to form univalent filaments, which join laterally in pairs to form bivalent loops. The filaments, after forming these loops, separate except at their ends. These are the meiotic bivalent chromosomes. At the first meiotic division, the pairs of whole somatic chromosomes, joined by their ends, separate and are distributed, half to each daughter cell. The longitudinal split in the daughter chromosomes of the somatic division which reappears in the telophase of the first meiotic division, is not consummated until the second meiotic division. The term "exeilesis" is suggested for the process by which each of the daughter chromosomes becomes converted into two semivalent threads.—J. **Needham** and Dorothy **Needham**: Further micro-injection studies on the oxidation-reduction potential of the cell interior. The results of the micro-injection of pH and rH indicators into living cells have been investigated. Oxidation-reduction potential indicators exhibit no anomalies when injected into *Amœba proteus*. It appears, therefore, that all the dyes on the scale may be used with biological material. The amœba is capable of oxidising the leucoform of indicators of lower oxidation-reduction potential, and the latter is probably independent of the percentage of oxygen in the external atmosphere. *Nyctotherus cordiformis* (an anaerobic protozoon) possesses an internal pH of 7·1 and an internal rH of 19·0-20·0 under aerobic conditions, while under anaerobic conditions, the latter changes to 9·5-10·5.—J. W. H. **Harrison** and F. C. **Garrett**: The induction of melanism in the Lepidoptera and its subsequent inheritance. Both in the British Isles and on the Continent in large manufacturing and urban areas, melanic forms have arisen. The conditions point immediately to the smoke in the atmosphere of large towns as responsible for the melanism and, moreover, indicate that it influences insects in the larval state by means of their food-plants. Thus it should be possible to induce melanism by (1) feeding up non-melanic strains of Lepidoptera in melanic districts, and (2) feeding them in non-melanic areas on food-plants artificially charged with impurities known to exist in or on the foliage of plants found in manufacturing centres. Both methods were employed on *Selenia bilunaria*, *Tephrosia crepuscularia*, and *T. bistortata*. Melanic examples appeared in all the experimental broods, and in numbers diverging widely from Mendelian expectation. The melanism so induced in *Selenia bilunaria* and *Tephrosia bistortata* behaved as a Mendelian recessive, while in *T. crepuscularia* it acts as a dominant.—J. **Gray**: The mechanism of ciliary movement.—(v.) The effect of ions on the duration of beat.—N. H. W. **Maclaren**: The early development of Cavia: Note on associated remains of previous placentation.

Linnean Society, January 21.—H. B. **Fantham** and Annie **Porter**: On two protozoan parasites found in the latex of *Ficus edulis* and *Euphorbia striata*. Two species of herpetemonads were found respectively in the latex of *Euphorbia striata* and *Ficus edulis* in Johannesburg, South Africa; the former is probably a strain of *Herpetomonas* (*Leptomonas*) *davidi*, and the latter is regarded as a new species. The plants parasitised do not show any marked pathological symptoms, the infection being localised. The number of infected plants was very small in each case. The possible source of the herpetemonads is of interest. They are best known as parasites of the alimentary tract of insects, both blood-sucking and non-blood-sucking. Marks of punctures, very probably made by the proboscides of plant-feeding Hemiptera, were seen on the Euphorbia, while green flies, Lucilia sp., were found on the fig-leaves, which may have inoculated the flagellates into the latex of the plants. They occur in man and dogs under the name of *Leishmania kala-azar*, and skin-sores are caused by them. It is interesting to find the latex of certain plants forming a natural reserve of herpetemonads.—H. H. **Thomas**: Discussion: The relation between the Caytoniales and modern flowering plants. The recently described Caytoniales are of some interest because they were Angiosperms without flowers, their reproductive structures being megasporophylls bearing carpels and microsporophylls bearing anthers. A single carpel and a single anther of this fossil type can be compared somewhat closely with the corresponding structures in the modern flower. It is unlikely that the Caytoniales represent the direct ancestors of the flowering plants, but they may be derived from the same stock which gave rise to that group. Assuming some relationship, the structure of Caytonia points to the carpels of the primitive Angiosperms having double rows of ovules produced in a dorsal median position near the vascular strands, rather than to the occurrence of marginal ovules produced on the sides farthest away from the vascular strands. Caytonia and Gristhorpia were undoubtedly wind-pollinated, and contained many ovules in each carpel. They can therefore be cited in opposition to the views (Robertson) that the primitive Angiosperms were insect-pollinated. The seeds of the Caytoniales are small in size and do not agree with the view that the primitive Angiosperm seeds were large like those of Cycas. The comparison of the microsporophylls (*Antholitus Arberi*) with the modern stamens may indicate that the primitive anther had four equal pollen-sacs arranged longitudinally, and was inserted by its base on the filament. A group of plants resembling both the Caytoniales and the Bennettitales, and also derived from the Pteridosperms, is suggested as the origin of many flowering plants. Recent discoveries tend to show that the Angiosperms originated at a much earlier period than was formerly supposed, and that at least one group of early Angiosperms achieved a very wide distribution in early Mesozoic times.

PARIS.

Academy of Sciences, January 11.—Pierre **Weiss**: Paramagnetism independent of the temperature. Solutions of luteocobaltic chloride and of potassium bichromate possess a magnetisation coefficient independent of the temperature. This fact is of importance in the theories of paramagnetism. A discussion of the possible hypotheses leads to the conclusion that constant paramagnetism should be an intra-atomic phenomenon.—Ph. Le **Corbeiller**: The substitutions of the complex modular group.—Ladislas **Nikliborc**: Hyperharmonic functions.—J. Kampé de **Fériet**: The uniformisation of a class of functions defined by integral series with meromorph coefficients.—Constant **Lurquin**: Binary covariation.—— **Kivelioviteh**: The conditions of a binary shock in the problem of three bodies.—Emile **Belot**: Remarks on the dense internal nucleus of the sun and on the movement of sunspots in latitude.—— **Pauthenier**. The photographic measurement of the electrostriction in the case of carbon tetrachloride. The experiments described are in good agreement with theory for the case of carbon tetrachloride.—H. **Pélabon**: Detection and the stability of certain detectors. Any imperfect contact metal-dielectric-metal may be used as a detector of wireless waves. If the dielectric interposed is gaseous the detector obtained is unusable on account of its extreme instability due to temperature changes. Powdered, badly-conducting solids form stable detectors.—— **Andrieux**: The electrolysis at a high temperature of oxides dissolved in boric acid or in borates. Details of a method by which sodium can be obtained by the electrolysis of borax.—— **Baykoff**: The theory of hardening of hydraulic cements. The author considers that three stages can be traced in the hardening of cement. The first stage is one of solution during which the liquid becomes saturated with the various soluble constituents. In the second stage all the products of the chemical reaction enter into the colloidal state. This corresponds to the commencement of the setting. In the final stage the gels are transformed into crystalline aggregates and this is the period of hardening.—A. **Kling** and A. **Lassieur**: The stability of solutions of carbonic acid. In a previous communication the authors have shown that water, purified as completely as possible, possesses an acid reaction, corresponding to $pH = 5{\cdot}8$. One plausible explanation of this would be that it is due to retained carbon dioxide. Direct experiment proved that a solution of carbon dioxide in highly purified water lost the whole of its carbon dioxide on exposure to air and gave the same acidity (5·8) as water purified without access to carbon dioxide.—Georges **Delbart**: Study of the fragility of cold drawn steel.—T. **Karantassis**: Researches on stannous chloro-iodide, bromo-iodide, and chloro-bromide. Data are given in support of the existence of the definite compounds $SnICl$, $SnIBr$, and $SnClBr$.—J. **Bougault**: An example of ether-oxide of a hydrated ketone.—M. **Faillebin**. The hydrogenation of ketones in the presence of pure and impure platinum black. It has been shown in earlier communications that the reduction products of ketones and aldehydes by hydrogen in the presence of platinum black are affected by the purity of the platinum. In the present paper an attempt is made to study the mechanism of the phenomenon. A platinum-iron catalyst was treated with a mixture of acetic acid and acetylacetone to remove the iron. The catalyst thus obtained functions as pure platinum black in the reduction of ethyl acetoacetate.—Raymond **Delaby**: The catalytic oxidation of vinylalkylcarbinols into vinylalkylketones in the presence of palladium black The oxidation of unsaturated secondary alcohols can only be carried out in a gaseous system at low pressures, but the yields are not good.—André Cornillot: The bis-phthalide carboxylic esters.—P. **Gaubert**: Detection (in wireless telephony) and the facies of crystals of galena and pyrites.—Conrad **Kilian**: The proportion in which the Silurian period is represented by its formation of the Tessilian enclosure, and on the presence of the Ordovician in the Sahara.—G. **Georgalas** and N. **Liatsikas**. The spectrum analysis of the flames from the Santorin volcano (eruption of 1925). From the lines recorded in the spectrograph, the gaseous mixture issuing from the central dome of the volcano contained hydrogen, vapour of sodium chloride, oxygen, nitrogen, and probably ferric chloride.—F. X. **Skupieński**: The evolutive cycle in *Didymium difforme*.—A. **Hée**: The influence of temperature on the intensity of respiration of submerged plants The plants studied were *Elodea canadensis*, *Myriophyllum spicatum*, and Cladophora, and the temperatures varied between 10° C and 39°·5 C. The respiration increased with rise of temperature and there was no optimum temperature.—P. P. **Stanescu**: The quantitative variations of the carbohydrates in the leaves of green plants in the course of a day.—M. **Bridel** and C. **Béguin**: The application of the biochemical method of research to the glucosides undergoing hydrolysis by rhamnodiastase to the study of the fresh roots of *Polygonum cuspidatum*. The production of a new glucoside, polydatoside. The results of the action of rhamnodiastase on the root extract indicated the presence of a new glucoside. Details of the mode of extraction and purification of this substance are given, together with its physical and chemical properties.—L. **Mercier**: The orthogenesis of the longitudinal vibrator muscles of flight in the Diptera.—Jean **Piveteau**: The importance of structural characters in the interpretation of certain fossils classed with the reptiles.—Maurice **Aubertot**: The contractility of the excretory apparatus in the larvæ of *Rhabditis pellio*.—L. M. **Bétancès**: The genesis of the hæmatopoietic organs and of the blood cells in the invertebrates.—A. **Policard**: The movements of sarcomatous cells cultivated *in vitro*. The most marked characteristic of the sarcomatous cells is incessant and rapid amœboid movement.—**Raymond-Hamet**: The action of yohimbine and the active alkaloids of ergot on the sympathetic vasomotor innervation of the kidney.—J. **Risler** and **Foveau de Courmelles**: The physiological action of the ultra-violet rays transmitted by the thin glass in ordinary use. It is generally held that ultra-violet rays emitted by a source of light in the interior of a glass apparatus are not harmful. Four cases of accident resulting from the use of apparatus constructed of light glass are described which show that injurious effects on the skin can be produced by the absorption of rays in the region between $\lambda = 2960$ Å.U. and $\lambda = 3120$ Å.U.—Daniel **Berthelot**: Remarks on the preceding communication. Additional data confirming the results.—R **Fosse**: The formation, by heating plant juices, of urea and of a substance giving the same hydrazine colour reaction as formol. The simultaneous formation, by heating plant juices, of urea and of a substance giving the colour reaction of formol, results from the hydrolysis of a ureide.—G. **Delamare** and Saïd **Djémil**: Abnormal forms of *Plasmodium vivax*.—A. **Paillot**: A new disease of the nucleus or *grasserie* of the larvæ of *Pieris brassicæ* and a new group of micro-organisms.—Mme. **Phisalix**: The natural immunity of the eel against the virus of hydrophobia and the rabicidal action of its serum. The eel is naturally refractory to hydrophobia and its serum destroys the virus of hydrophobia *in vitro*. The serum can also be used to protect animals against hydrophobia.—B. **Issatchenko**: Nitrification in the sea.—X. **Debedat**: Ulcerated Röntgen epitheliomas cured by high frequency treatment (diathermo-coagulation). After giving details of his own cure by this treatment, the author concludes that radiologists need not die of cancer brought on by their work.

Official Publications Received.

Board of Trade. Catalogue of the British Industries Fair 1926, The White City, Shepherds Bush, London, W.12, February 15th–26th. Organised by the Department of Overseas Trade. Pp. xxx+176+112. (London: Department of Overseas Trade.) 1s.

Memoirs of the Asiatic Society of Bengal. Vol. 6: Zoological Results of a Tour in the Far East. Edited by Dr. N. Annandale. Part 10: The Amphipoda of Tale Sap. By Dr Chas. Chilton. Pp 531-558. 1.2 rupees. Vol. 9, No. 2: Geographic and Oceanographic Research in Indian Waters. By Major R. B. Seymour Sewell. Part 2: A Study of the Nature of the Sea-Bed and of the Deep-Sea Deposits of the Andaman Sea and Bay of Bengal. Pp 27-50+plates 6-7. 2.4 rupees. (Calcutta.)

Meddelelser fra Kommissionen for Havundersøgelser. Serie Fiskeri, Bind 8, Nr. 1: On the Age and Growth of the Haddock (*Gadus aeglefinus* L.) and the Whiting (*Gadus merlangus* L.) in Icelandic Waters By Bjarni Sæmundsson. Pp. 33. Serie Fiskeri, Bind 8, Nr. 2: On the Diurnal Vertical Movements of Young of some Fishes in Danish Waters. By Dr. A. C. Johansen. Pp. 27. (København: C. A. Reitzel.)

Proceedings of the Royal Irish Academy. Vol. 37, Section A, No. 2: A Quaternion Substitute for the Theory of Tensors. By W. J. Johnston. Pp 13-27. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1s.

Union of South Africa. Department of Mines and Industries: Geological Survey. Geological Map of the Union of South Africa. On the Scale of One to a Million. In 4 Sheets, 40 in × 30 in. The Geological Structure of the Union: an Explanation of the Geological Map of the Union of South Africa. By Dr. A. W. Rogers. Pp. 24. 6d. Map with Explanation, 20s. (Pretoria: Government Printing and Stationery Office.)

Diary of Societies.

SATURDAY, FEBRUARY 20.

BRITISH PSYCHOLOGICAL SOCIETY (Industrial Section) (at National Institute of Industrial Psychology, 329 High Holborn), at 11.30.—Prof. Pear: What is meant by Skill in Industry.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. G. Macdonald: Roman Britain (1).

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.), at 3.—G. Avenell: A Glance at Richard Jefferies (Lecture).

PHYSIOLOGICAL SOCIETY (at King's College).

MONDAY, FEBRUARY 22.

ROYAL IRISH ACADEMY (Dublin), at 4.15.

ROYAL SOCIETY, EDINBURGH, at 4.30.—Rev. T. C. Gordon: The Finding of the Galilee Skull.—Prof. A. Robinson: A Scientific Description of a Neanderthal Skull found in Galilee, from a Cast.

INSTITUTE OF ACTUARIES, at 5.—C. R. V. Coutts: On the Distribution of Life Office Profits.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Fossil Remains of Ape and Man (1): The Taungs Anthropoid: its Zoological and Geological Position.

FARADAY SOCIETY (at Chemical Society), at 5.30.—Prof. A. J. Allmand and R. H. D. Barklie: The Influence of Alternating Currents on the Electrolytic Corrosion of Iron.—A. N. Campbell: The Direct Oxidation of Manganous Ion to Permanganate.—H. J. Poole: The Elasticity of Jellies of Cellulose Acetate in Relation to their Physical Structure and Chemical Equilibria.—F. G. Tryhorn and W. F. Wyatt: Adsorption II. The Adsorption by a Coconut Charcoal of Saturated Vapours of some Pure Liquids. Adsorption III. Stages in the Adsorption by a Coconut Charcoal from the Saturated Vapour over Liquid Mixtures of Alcohol and Benzene and of Acetone and Benzene.—L. R. McHaffie: A Device for Circulating Fluids under High Pressure

BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Bedford College for Women), at 5.30.—Prof. J. Johnstone: The Organism and its Environment (Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—A. F. Harmer and others: Discussion on Some Changing Characteristics in the Application of Electricity to Public Supply.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—J. L. Thompson and H. Walmsley: Notes on the Testing of Static Transformers.

INSTITUTION OF STRUCTURAL ENGINEERS (Midland Counties Branch) (at Birmingham), at 7.30.—H. F. Lea: Arterial Road Construction.

ROYAL SOCIETY OF ARTS, at 8.—Dr. G. W. C. Kaye: The Production and Measurement of High Vacua (Cantor Lectures) (2).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Sir Frank Colyer: Abnormal Teeth from the Region of the Premaxilla.

RAILWAY CLUB (at 65 Belgrave Road), at 8.15.—B. M. Bailey: Development of the Railway Carriage.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.

TUESDAY, FEBRUARY 23.

ROYAL DUBLIN SOCIETY (at Balls Bridge, Dublin), at 4.15.—Prof. W. E. Adeney and Miss B. B. Dawson: The Estimation of Organic Matter in Water by means of Potassium Bichromate and Sulphuric Acid.—T. G. Mason and C. J. Lewin: On the Rate of Carbohydrate Transport in the Greater Yam, *Dioscorea alata*, Linn.—Prof. J. Reilly: The Production of Lavender Oil from Irish Grown Plants.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: The Egg (2): The Shell.

LINNEAN SOCIETY, at 5.30.

ROYAL SOCIETY OF MEDICINE (Medicine, Electro-Therapeutics, Surgery, and Laryngology Sections), at 5.30.—Dr. L. S. T. Burrell, Dr. S. Melville, J. E. H. Roberts, S. Hastings, Dr. W. Gordon, H. M. Woodman, Dr. R. Knox, Dr. D. Forrest, Sir Charlton Briscoe, and others: Discussion on The Diagnosis and Treatment of Intra-thoracic New Growths.

BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Bedford College for Women), at 5.30.—Prof. L. J. Russell: The Philosophical Problems within Science (Lecture).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. H. H. Scott: Report on the Deaths occurring in the Society's Gardens during the Year 1925.—W. E. Le Gros Clark and the late Dr. C. F. Sonntag: A Monograph of *Orycteropus afer*. III. The Skull, Skeleton of the Trunk and Limbs, and General Summary.—Dr. Marie V. Lebour: The Young of *Stylocheiron suhmii* G. O. Sars and *Stylocheiron abbreviatum* G. O. Sars (Crustacea), from Mediterranean Plankton collected by Mr. F. S. Russell in the Neighbourhood of Alexandria, Egypt.—Oldfield Thomas: On Mammals from Ovamboland and the Cunene River, obtained during Capt. Shortridge's Third Percy Sladen and Kaffrarian Museum Expedition into South-West Africa.—Helen M. England: Development of Gonophores of the Stylasteridæ.

INSTITUTION OF CIVIL ENGINEERS, at 6.—V. Bayley: The Khyber Railway.—Col. G. R. Hearn: The Survey and Construction of the Khyber Railway.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—F. S. Clifford: The Principles and Practice of Automatic Steering.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—A. Keighley: Palestine (Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—H. Parodi: The Electrification of the Paris-Orleans Railway.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 7.15.—A. A. Perks: The Heat Reactions occurring during the Vulcanisation of Rubber.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.

ROYAL ANTHROPOLOGICAL INSTITUTE (Indian Section), at 8.15.—R. E. Enthoven: Ethnographic Research in India.

WEDNESDAY, FEBRUARY 24.

INSTITUTE OF HYGIENE, at 3.30.—Dr. L. R. Lempriere: Diet in Schools.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Fossil Remains of Ape and Man (3): Fossil Anthropoids of Europe and of Asia.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. G. L. Elles: The Geological Structure of Ben Lawers and Meall Corranaich (Perthshire).

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at the Science Museum, South Kensington), at 5.30.—G. F. Tyas: Matthew Murray—A Centenary Appreciation.

BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at University of London Club), at 5.30.—Hon. Bertrand Russell: The Structure of the World (Lecture).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Neville Hall, Newcastle-upon-Tyne), at 7.

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section) (at University College, Nottingham), at 7.30.—S. R. Trotman and Dr. E. R. Trotman: Further Experiments on the Chlorination of Wool.—Dr. E. R. Trotman: The Determination of Dissolved Oxygen in Effluents.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section), at 7.30.—Kodak, Ltd.: Practical Demonstration of the Eastman Colorimeter.—C. A. Klein: The Application of the Microscope to the Examination of Pigments and Paints.

ROYAL SOCIETY OF ARTS, at 8.—Dr. Mary Fishenden: Domestic Heating.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine), at 8.30.—Dr. J. T. MacCurdy: A Hypothetical Mental Constitution of Compulsive Thinkers.

MEDICAL SOCIETY OF LONDON, at 9.—Dr. F. Buzzard: The Principles of Treatment in relation to Diseases of the Nervous System (Lettsomian Lectures) (2).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section—Newcastle) (at Armstrong College).—Prof. C. J. Hawkes: The New Engineering Laboratories at Armstrong College.

THURSDAY, FEBRUARY 25.

ROYAL SOCIETY, at 4.30.—C. R. Baldwin and Prof. G. B. Jeffery: (*a*) The Relativity Theory of Plane Waves; (*b*) Electronic Orbits on the Relativity Theory.—Margaret Stimson and Prof. G. B. Jeffery: The Motion of Two Spheres in a Viscous Fluid.—A. L. McAulay and F. P. Bowden: Evidence for a Film Theory of Hydrogen Overpotential from Surface Tension Measurements.—*To be read in title only.*—J. H. Wolfenden: Critical Potentials of Hydrogen in the Presence of Catalytic Nickel and Copper.—J. P. McHutchison: Adsorption Experiments with Radium D and Radium E.—J. S. Dunn: (1) High Temperature Oxidation of Metals. (2) The Low Temperature Oxidation of Copper.—Prof. J. Heyrovsky: A Note on The Significance of the Electrode Potential.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. C. D. Ellis: The Atom of Light and the Atom of Electricity (1).

INSTITUTION OF MINING AND METALLURGY (at Geological Society of London), at 5.30.

BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Royal Anthropological Institute), at 5.30.—H. J. Laski: Politics in Literature. H. G. Wells (Lecture).

ROYAL AERONAUTICAL SOCIETY, at 6.30.—A. J. Cobham: Long Distance Aeroplane Flights.

BRITISH ASTRONOMICAL ASSOCIATION (West of Scotland Section) (at Royal Technical College, Glasgow), at 7.30.—J. J. Ross: The Moon's Motions and Ocean Tides.

OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—C. Aves: Notes on the Significance and Detection of Low Errors of Refraction.—W. H. A. Fincham: Vertex Power and its Measurement.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre (Dublin)) (at Trinity College, Dublin), at 7.45.—Prof. S. P. Smith: An All-Electric House.

INSTITUTE OF CHEMISTRY STUDENTS' ASSOCIATION (London), at 8.—F. H. Carr: The Transference of Chemical Processes to the Large Scale.

FRIDAY, FEBRUARY 26.

ROYAL SANITARY INSTITUTE (in Municipal Buildings, Middlesbrough), at 4.—Dr. Grace Dundas, Dr. C. V. Dingle, and others: Discussions on the Malthriving Infant, the Present Type of Smallpox, Organic Salvage, and Housing and Main Drainage.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section) (at Paddington Green Children's Hospital, W.2), at 4.30.—Clinical Meeting.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—J. H. Calthrop: The Effects of Torsion upon the Thermal and Electrical Conductivities of Aluminium, with special reference to Single Crystals.—T. H. Harrison: A Study of the Concurrent Variations in the Thermionic and Photo-Electric Emission from Platinum and Tungsten with the State of the Surfaces of these Metals.—C. R. Darling and E. Edser: Demonstrations illustrating Surface Tension and Capillary Phenomena.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Fossil Remains of Ape and Man (4): The Kivu Gorilla and its Bearing on the Problems of Human Evolution.

BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Royal Anthropological Institute), at 5.30.—Prof. T. H. Pear: The Gestalt Theory (Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (jointly with Institute of Chemistry) (at 39 Elmbank Crescent, Glasgow), at 7.—Prof. R. A. Berry: Soil Nitrogen.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Swansea Technical College), at 7.30.—E. A. Tyler: Some Notes on Pure Chemicals: An Inquiry into the Purity of Available Supplies.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle-upon-Tyne), at 7.30.—J. Richardson: Hydro-Mechanical Gearing.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. F. Petree: Seven Thousand Years of Shipping.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. C. Hagberg Wright: Nicolas de Peiresc and his Circle: The Story of a 17th Century Patron of Learning.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

INSTITUTION OF MECHANICAL ENGINEERS (Sheffield Branch).—Informal Discussion.

SATURDAY, FEBRUARY 27.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 3.—F. J. Johnston: The Use of Breathing Apparatus in Mines.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. G. Macdonald: Roman Britain (2).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 20.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Gordon V. Childe: Ancient Crete and the Myths of the Greeks.

MONDAY, FEBRUARY 22.

KING'S COLLEGE, at 5.30.—Prof. A. S. Eddington: The Constitution and Evolution of the Stars. (Succeeding Lectures on February 24 and March 1.)

ST. THOMAS'S HOSPITAL MEDICAL SCHOOL, at 5.30.—Prof. D. Murray Lyon: Some Principles of Therapeutics. (Succeeding Lectures on February 23 and 24.)

TUESDAY, FEBRUARY 23.

GRESHAM COLLEGE, at 6.—A. R. Hinks: Astronomy. (Succeeding Lectures on February 24, 25, and 26.)

WEDNESDAY, FEBRUARY 24.

SCHOOL OF ORIENTAL STUDIES, at 5.15.—Prof. E. Herzfeld: Persian Archæology (James G. R. Forlong Lectures). (Succeeding Lectures on March 3, 8, and 12.)

FRIDAY, FEBRUARY 26.

MUNICIPAL TECHNICAL SCHOOL, BIRMINGHAM, at 7.15.—Dr. J. Newton Friend: Historical Chemistry: Phlogistic Period and Joseph Priestley.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Dr. H. T. Calvert: The Activated Sludge Process of Sewage Treatment (Chadwick Lecture).

SATURDAY, FEBRUARY 27.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—G. C. Robson: Squids, Cuttlefishes, and their Allies.

CONFERENCE.

FRIDAY, FEBRUARY 19, AND *SATURDAY*, FEBRUARY 20.

UNIVERSITY, BIRMINGHAM.—Inter-University Metallurgical Conference.—The Metallurgical Student: His Place in Industry.

SATURDAY, FEBRUARY 27, 1926.

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Problems of Immunity and Infection: the Filter-passing Viruses.

In investigations on the effects produced in the body by invading micro-organisms, much attention has been directed towards an analysis of the defensive reactions of the former, but fewer observations have been made with regard to the offensive powers of the latter. Thus it is well known that the leucocytes or white cells of the blood, the wandering cells of the tissues, and certain of the endothelial cells lining the blood capillaries, are a part of the defensive mechanism of the body against bacteria or other particulate matter, which they ingest, and, if possible, destroy, whilst a further line of defence is represented by the different types of immune bodies which are present in the cells and tissue fluids or are developed therein in response to the invasion. The factors on which the infectivity, or virulence, of an organism depends are, however, less certainly understood, although variations in virulence quite apart from variations in the defensive powers of the host have been frequently observed. The "Report of the Medical Research Council for 1924–1925" lays stress on this aspect of the question, which has assumed considerable importance from the recent work of Gye and Barnard on cancer.

It has been known for some time that certain organisms are, by themselves, non-virulent: thus, the bacilli or spores of tetanus, or lockjaw, and those of gas gangrene, if thoroughly washed, produce no ill-effects on injection into the animal body. Gye and Cramer found that a minute quantity of a calcium salt, or of silica, both common constituents of the soil in which the organisms occur, injected along with them enabled them to act with their full virulence. A somewhat similar relationship was observed by Gye and Kettle with regard to the growth of the tubercle bacillus in the presence of silica, a relationship which is seen clinically in the association of pulmonary tuberculosis with silicosis in 'miners' phthisis.' It is of interest that some protozoa also seem to require the presence of some associated factor before they become virulent: thus, Dobell has found the *Entamœba histolytica*, the amœba responsible for one type of human dysentery, in the intestine of many people in Great Britain, yet the disease itself is very rare.

It will be recalled that the work of Gye and Barnard on cancer offers a very close analogy to the above-mentioned examples of the association of an organism with some 'specific' factor necessary for the development of the power of infectivity. The difficulty facing the hypothesis of the infective nature of cancer has always been the impossibility of transferring the tumour from one animal to another of a different species, and even in the case of animals of the same species, transference is only possible with the living tumour cells. On the other hand, the microscopical appearances of a single variety of cancer in different species are the same, suggesting definitely a similarity of origin. The investigations of Gye and Barnard reconcile these two points of view by showing that the disease depends on the presence of a micro-organism acting in association with a 'specific' chemical factor.

Although usually the inoculation of an animal with a tumour only produces a growth when the living tumour cells are implanted, a few exceptions to this statement are known; thus, the Rous fowl sarcoma is caused by an agent which passes through the finest filters and has for long been believed to be a filter-passing micro-organism. Gye proved that this virus is actually corpuscular, since it can be shifted in fluids by the application of a centrifugal force and in pure culture, in the technique of which he was also successful, can be photographed by means of ultra-violet light by the method devised by Barnard. The presence or absence of the organism, determined experimentally by Gye, was confirmed microscopically by Barnard, thus increasing confidence in the results obtained by each author. But the greatest interest, perhaps, lies in the demonstration that the organism itself failed to produce any tumour when inoculated into fowls: it was only when an extract of tumour tissue in which there were no living organisms was inoculated together with the virus that a growth appeared. It was found on further work that the microbe could be obtained from other animals or tumours, but that the second non-living factor was 'specific,' in the sense that the type of tumour and its actual occurrence in an inoculated fowl depended upon the former's presence. The work suggests that the organism can only produce a tumour when the 'soil' is suitable for its growth: the many agents to which the origin of different cancers is ascribed, such as various irritants, may perhaps act by production of a favourable 'soil,' in other words, by causing the cells of the tissues to form, in the course of their, probably abnormal, metabolism, a chemical substance, which, in the present state of our knowledge, can only be described as the 'specific factor.'

The work of Gye and Barnard lends additional importance to investigations of the other filter-passing viruses and the diseases caused by them, among which may be mentioned canine distemper, 'sleepy sickness' (*Encephalitis lethargica*), herpes, vaccinia (cowpox) and variola (smallpox). That methods which are used for the investigation of the properties and effects of ordinary bacteria are applicable to the study of these viruses has been shown in the case of vaccinia and variola by Gordon. He has found that different samples of vaccine lymph obtained from calves and used in the vaccination of human beings against smallpox contain the same virus, and that the viruses from different smallpox epidemics tested against anti-vaccinia serum, all gave positive results. The fact that the immunity reactions given by this group of 'ultra-microscopic' organisms are similar to those given by the more common bacteria suggests that investigations on the other filter-passers, such as the viruses of cancer and canine distemper, can be undertaken with the hope of adding greatly to our knowledge concerning them. Work in connexion with the latter disease is being carried on in association with the *Field* Distemper Fund. It has been found that the disease can be transmitted to ferrets, which may thus be used for much of the experimental work; the virus is undoubtedly a filter-passer, although it has not yet been isolated or cultivated *in vitro*; the disease is extremely infectious, and it appears possible that the virus is air-borne, at any rate over short distances, necessitating adherence to a scrupulous technique on the part of all those concerned in the investigation.

Two further points may be very briefly considered. Although the chemical nature of Gye's 'specific factor' is quite unknown, there is no reason why further research should not throw light upon its general chemical properties, in the same way that recent work has brought an increased knowledge of the chemistry of the compounds involved in the immunity reactions of the body. Dudley and Laidlaw have obtained from tubercle bacilli a substance which forms precipitates in high dilutions with the serum of animals immunised against the whole protein constituents of the bacilli, although it will not itself evoke the production of such a serum. On analysis, the substance was found to be a complex carbohydrate of the nature of a gum, yielding pentoses and a more resistant nucleus on hydrolysis. Again, Hartley has shown that certain of the reactions between diphtheria toxin and antitoxin are caused by the ether-soluble constituents of the serum, whereas others occur independently of this fraction.

Finally, mention should be made of the question of treatment: the work on the filter-passing viruses having shown their close relationship with the microscopic bacteria, so far as the responses of the body are concerned, the outlook for a specific therapy is brighter than might otherwise have been the case. Meanwhile, the investigation of chemical compounds with a bactericidal action is being continued, especially in connexion with tuberculosis: both sanocrysin and certain oils have claimed the particular attention of numerous workers. An interesting point in connexion with the latter is the discovery by Griffith that the germicidal power of the oils is increased by exposure to the sun's rays, owing to chemical changes which they undergo in the light. One may recall the formation of the anti-rachitic vitamin in similar circumstances, and the beneficial effects of sources of the fat-soluble vitamins in this disease.

The many points on which our knowledge of micro-organisms is advancing suggest a hopeful outlook with regard to the treatment of cancer and tuberculosis, two of the great scourges of mankind. Although a certain cure is not yet obtained, and may be still far distant, a cautious optimism with regard to the position appears to be justified.

Spitsbergen Papers.

Spitsbergen Papers. Vol. 1. Scientific Results of the First Oxford University Expedition to Spitsbergen (1921). Pp. xi+454+17 plates. (London: Oxford University Press, 1925.) 30*s*. net.

BRITISH tradition in Spitsbergen dates from Stuart times, when English sailors explored the coasts and fiords of that northern land. Later, Phipps, with whom was the midshipman destined to be Lord Nelson, and Lord Dufferin, added to our associations. Scientifically, however, the tradition is barely half a century old, Sir Martin Conway's expedition being virtually the first serious attempt of British men of science to grapple with the problems—geographical and geological—of Spitsbergen. Within the last few years, the exploration work of the late Dr. W. S. Bruce, the detailed geological investigations of the Scottish Spitsbergen Syndicate, and the results of the several Oxford University expeditions, have put the seal upon our interest and research.

The present work, which is the first volume of the results of the four Oxford expeditions and is devoted to the researches of the first (1921) party, consists of thirty-two reprints of papers, retaining the format and pagination of the scientific journals in which they originally appeared, with an appendix on Polyzoa and Tunicata which has not previously been published.

In the preface to the volume, the writer states that the original idea was that the expedition should be purely ornithological. Later, however, the personnel was increased to include representatives of the other natural sciences, with the result that the book contains articles on subjects ranging from rotifiers and lichens to topography, glaciology, and the courtship of birds. The party finally consisted of eighteen men under the leadership of the Rev. F. C. R. Jourdain, and with the title of the Oxford University Expedition to Spitsbergen.

The expedition consisted of two parties which spent almost three months in the archipelago, visiting Bear Island, Prince Charles Foreland, and the west coast of Spitsbergen generally, and Ice Fiord in particular. The scientific results obtained were published as soon as possible in the appropriate journals, so that specialists have already seen the results that most concern them.

The results may be divided into two groups: those which deal with topographical and geological work, and those concerned with the zoological and botanical observations made by the expedition. The former is represented by three papers of great interest. Mr. R. A. Frazer gives an account of the topographical work of the expedition, which was mainly in the nature of a reconnaissance and consisted principally of a sledge journey into the area north-east of Ice Fiord known as Garwoodland and New Friesland. In another paper Messrs. Huxley and Odell describe in detail the nature, and their theories of the formation, of the peculiar stone and fissure polygons and other surface markings seen so well in Spitsbergen. This paper is of special importance in view of the fact that it was only so recently as 1914 that Högbom, for the first time, put forward a feasible explanation of the phenomena. Mr. Slater's observations on the Nordenskiöld and neighbouring glaciers are also worthy of close study in view of the analogies (already noted by Garwood and Gregory) to be drawn between certain glacial phenomena in Spitsbergen and British drift deposits.

The biological papers are of exceptional interest from an ecological point of view. Spitsbergen occupies a peculiarly favoured position for such study, being a fairly accessible region for the explorer, yet sufficiently isolated to maintain a relatively simple fauna and flora. In addition, a great number of observations had already been recorded by other workers. Full advantage was taken by the Oxford Expedition of the opportunities thus afforded, as is evidenced by the published results. In a work of this kind, it is an invidious task to select papers of outstanding merit, but the "Contributions to the Ecology of Spitsbergen and Bear Island" by Messrs. Summerhayes and Elton is one of the most striking contributions yet made to Arctic biology. In this paper the authors describe the plant and animal communities of part of Bear Island and Spitsbergen (Prince Charles Foreland, Cape Boheman, and various parts of Ice Fiord). The succession of plant communities is traced, a noteworthy feature being the relative abundance of cryptogams, especially Bryophyta. The proportion of this group is particularly high upon the maritime coasts, which is no doubt due to the increase in humidity. The number of species, both plant and animal, is small, the severity of climatic conditions, geographical isolation, and the absence of distinct night and day being the chief factors held responsible. In addition, the authors give a sketch of the food cycle in Bear Island.

The remainder of the papers, apart from a few on ecological problems, are devoted to additions to systematic zoology and botany.

The volume, since it unites a somewhat scattered literature, will prove useful to libraries, universities, and other institutions, besides appealing to the ever-increasing number to whom Spitsbergen is more than a geographical name. The absence of an index in a work like this is of no real importance, but one hopes that the printers, not the authors, are responsible for the occasional lapses in the spelling of geographical names and for the 'die-hard' form "Spitzbergen," which once or twice makes its way into the text.

The results of the further Oxford expeditions will appear as the second volume of these papers, while other results, notably ornithological, will appear in book form. Perhaps one can say nothing better for the present part than that one looks forward with interest to the arrival of these future works. In the preface, the committee expresses the hope that other young scientific workers may have equal opportunities for similar experience. All who read these results will heartily echo this wish. Few countries offer so much of value for the young natural historian as Spitsbergen, and the work of the Oxford expeditions will prove an admirable guide. W. E. Swinton.

Products from Coal.

The Industrial Applications of Coal-Tar Products. By H. M. Bunbury and A. Davidson. Pp. xi + 284. (London: Ernest Benn, Ltd., 1925.) 42*s.* net.

The numerous products obtained from coal-tar are ever increasing in importance, not so much, perhaps, because of the isolation of new substances or new derivatives of the older materials recognised as being present therein, but more by reason of the utilisation of compounds hitherto known to be present, which have previously found no industrial application. In the preface to the book under review, the authors direct attention to the fact that no commercial use has yet been found for phenanthrene and fluorene, and it is indeed remarkable that this should be the case when it is remembered that phenanthrene is the basis of some of our most important natural alkaloids. Nevertheless, the other side of the picture tells a different story, and there can be no question that in the near future use will be found for these hydrocarbons just as use has now been found for such substances as acenaphthene and carbazole, compounds at one time regarded as laboratory rarities.

The materials required by the chief users of the coal-tar products, the fine chemical industry and the dyestuffs industry, are steadily advancing in complexity and intricacy, because the competition between the various interests leads to the production of new compounds possessing some small advantage over the older ones which enables them to compete successfully in the world's markets. It does not necessarily follow that complexity of structure implies commercial advantage, because some of the simpler products—for example, aniline black—still retain their places among the foremost of the dyes in use. But when the field of choice is so wide and the number of products so great, research will always find some particular substance which has special industrial advantages leading to a demand for its production, and the manufacturer is often prepared to meet this demand even though it entails a financial loss.

The progress of the dyestuffs industry, which is based on the products from coal-tar and the "intermediates" derived from them, is indicated by well-defined steps, each involving the utilisation of a new series of products. The initial production of the triphenylmethane dyes found employment for the coal-tar bases aniline, the toluidines, and so forth. The introduction of the substantive cotton dyes provided a use for naphthalene and the sulphonic acids of the naphthols and naphthylamines. The production of synthetic alizarine brought in anthracene and the tremendous step in advance made when Bohn discovered indanthrene provided a use for a variety of products hitherto either unknown or not utilised. Without question, the development of the industry depends on the production of new and suitable intermediate products or the preparation of old "intermediates" in a new and more economical manner, and it would seem that we are now about to enter a new era in this connexion which may affect our existing conditions of manufacture, because it entails a completely new kind of chemical technique.

The successful production of methyl alcohol (methanol) provides the "writing on the wall" and indicates the direction synthetic organic chemistry will take in the future. Every manufacturer interested in organic chemical reactions, and every organic research chemist, should keep the phrase "reactions at high temperatures and pressures in the presence of a catalyst" always before him, because we as a nation must not be behindhand in the new development.

The book under review is a well-thought-out attempt to group the industrially important material among the dyestuffs, explosives, and so forth, under the head of the industrial parent substance. The method is a good one, and enables the reader to find with little trouble any substance concerning which he may require information. The use of charts wherever possible facilitates reference and helps the reader to see at once the relationship between the various derivatives of some single parent substance. For example, Chart v. on pp. 116 and 117 gives a very clear and concise picture of the derivatives of naphthalene. The book is well printed, and the formulæ are clear and not too elaborate. It should find a place on the shelves of all those who are interested in the subject with which it deals. J. F. T.

South American Pit-Vipers.

A General Consideration of Snake Poisoning and Observations on Neotropical Pit-Vipers. By Afranio Do Amaral. (Contributions from the Harvard Institute for Tropical Biology and Medicine, 2.) Pp. vi+64+16 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1925.) 10*s.* 6*d.* net.

THE work under notice is a collection of four papers on the classification of the South American pit-vipers, prefaced by an essay on snake poisoning in general. In the preface, the nature of the poisons of the principal venomous snakes, their complexity, their action, the quantity of venom ejected, the symptoms seen in victims bitten by serpents of different kinds, and the serum treatment of snake bite is all surveyed in 20 pages. The materials for this survey have been selected with discretion, the information is accurate, and it forms a useful introduction to the subject of snake poisoning, but has no particular relation to the four short papers which follow it.

Of the serum treatment of snake poisoning, the author has had first-hand experience at the Butantan Institute at Sao Paulo, where he has been an assistant for some years. The Butantan Institute is the only place where the serum treatment of snake poisoning has been thoroughly exploited, first by Vital Brazil and latterly by Gomes. Here four classes of serums—anti-crotalic, anti-micrurus, polyvalent anti-bothropic, and polyvalent anti-ophidic—are manufactured and issued in concentrated form. Snake poisons are highly specific, and a serum produced against one species of snake is generally of little use against another, although some amount of overlapping occurs. Polyvalent sera are, therefore, necessary for treatment, as the particular species of serpent responsible for the bite cannot usually be identified and there is no time to spare, if the treatment is to be effectual.

As with poisoning by bacterial toxins, early administration of serum is essential. We do not agree with Dr. Amaral that the dosage and method of administration should be adapted to the "estimated" quantity of poison inoculated. We believe this to be dangerous advice, and that a full dose should be administered as soon as possible after the accident and by the intravenous route. If this is impracticable, the serum should be injected deeply into the muscles of the buttock. Anti-serum is but slowly absorbed from the subcutaneous tissue, and is at least twenty-five times as effective when injected directly into the circulation. Unfortunately, intravenous injection is rarely possible until some time afterwards, as the doctor is not usually present at the time of the accident. Notwithstanding all the disadvantages pertaining to the treatment of snake poisoning, the results in Brazil have been very encouraging.

The value of the preface would have been increased if a short bibliography had been attached to indicate to the serious student where the literature on snake poison may be found. Should such a one read this review, he may be glad to know that it is completely reviewed in vol. 2 of Marie Phisalix's wonderful book, "Animaux venimeux et venins" (Paris: Masson et Cie, 1922).

The four systematic papers contain a reasoned criticism of the present classification of the commoner pit-vipers and suggestions for their better arrangement, based upon the examination of upwards of 6000 living specimens of all ages. It may seem strange that one individual has had such a wealth of material at his disposal. This is explained by Dr. Amaral's connexion with the serum institute at Butantan, Brazil. Quantities of living snakes are procured by the Institute to supply venom for the immunisation of horses, and many are also sent for identification in order that the victim of snake bite may receive the appropriate anti-venom.

A re-examination of the classification of these South American vipers will be welcomed by herpetologists and others interested in their identification, as at present there is some confusion. The wealth of synonyms, too, is bewildering. In the British Museum catalogue of snakes, under *Lachesis lanceolatus*, there appear more than thirty synonyms. Dr. Boulenger, who is responsible for the catalogue, does, indeed, suggest that, under this designation, two or three different species may be confounded. In the opinion of Dr. Amaral, much of the confusion is due to the fact that European herpetologists have generally had only spirit specimens at their disposal, which had lost their colour, and have not had means of differentiating young from old snakes. As he shows in the second article in the book under review, "On the Evolution of Dorsal Markings," the pattern at different ages varies so greatly in some species, *e.g. Bothrops jararacussu*, that it might be supposed that one was dealing with different species.

The principal paper in the series is on the differentiation of the species *Bothrops atrox*, *B. jararaca*, and *B. jararacussu*. The author concludes that "echis" of most of the Spanish-American countries, the "fer-de-lance" of Martinique, the "barcin" of Trinidad, and the "caissaca" of Brazil are all one species, *Bothrops atrox* (Linné). The "jararaca" of Brazil and the "yarara" of the Argentine he found to be *B. jararaca* (Wied), and the "jararacussu" of Brazil and the "yararaguassu" of Argentine, Paraguay, and Bolivia to be *B. jararacussu* (Lacerda). He prefers the generic term "Bothrops" to that of "Lachesis," on the ground that this name was the first used, namely, by Linné so long ago as 1758. The three species differ in their habits of life. *B. atrox* prefers humid, wooded, and rocky places, and feeds on small rodents. *B. jararaca* prefers the open and is commonly encountered in hay-fields. It also devours small rodents. *B. jararacussu* is amphibious and feeds almost exclusively on batrachians. Their poisons are different. These three species are described in detail. The last of the series of papers deals with *Bothrops Neuwiedii,* which Dr. Amaral proposes to divide into four subspecies, on the ground of the fixity of their chromatic characters. Here he would appear to be on uncertain ground. The characteristics on which the proposed subdivision is based are associated with the habitat of the snakes, and there is no evidence that if they were translated from one locality to another the supposed fixity would be maintained.

The papers are accompanied by excellent plates. The coloured pictures of *B. atrox, B. jararaca,* and *B. jararacussu,* drawn from life, are beautiful.

C. J. M.

The Newcomen Society.

The Newcomen Society for the Study of the History of Engineering and Technology. Transactions, Vol. 4, 1923–1924. Pp. xii + 153 + 21 plates. (London: Secretary, Newcomen Society, Science Museum, 1925.) 20*s.*

THIS latest volume of *Transactions of the Newcomen Society* is one of wide interest. The subjects dealt with range from chain pumps of the seventh century to the earliest locomotives in America; from the dynamics of Leonardo da Vinci to the bibliography of the history of engineering and applied science. As a frontispiece there is a reproduction of the earliest known print of a Newcomen engine. This print is not only the earliest drawing, but also the earliest document of any kind known showing the construction of the engine. The original by Henry Beighton was only recently discovered in the Library of Worcester College, Oxford, by Mr. L. de M. Johnson, of the Oxford University Press. Though in the *Transactions* the drawing has had to be folded, copies can be obtained unfolded, and we think this historical drawing should be exhibited wherever mechanical engineering is taught.

The philosophical view of the work of the Society is well stated in the presidential address of Mr. Loughnan St. L. Pendred, while the biographical side is illustrated by a paper on the Rastricks—a family in which engineering skill was in some degree inherited. John U. Rastrick was a contemporary of George Stephenson, and his best memorial is the London and Brighton Railway.

Just as it is the aim of the Newcomen Society to further the study of the history of engineering and technology, so it was one of the objects of the Royal Society in its earliest years to collect and chronicle a history of the minor arts and trades. In his diary of January 16, 1660, John Evelyn wrote: "I went to the Philosophic Club where was examined the Torricellian experiment. I presented my circle of Mechanical Trades"; and in Dr. Birch's History of the Royal Society is an entry of the same date: "The Catalogue of Trades brought in by Mr. Evelyn and that of Dr. Petty were referred to them and Dr. Merret to be compared, methodised and returned to the Society." Evelyn's "Circle" has been preserved, and with a prefatory note by Mr. Forbes Sieveking is reproduced in this volume.

Two very different aspects of the iron industry in England are given in Mr. Rhys Jenkins' "Sketch of the Industrial History of the Coalbrookdale District," and in Mr. W. A. Young's paper, "Works Organisation in the 17th Century: some account of Ambrose and John Crowley." Iron founding has been carried out in the Coalbrookdale district for centuries, and here the problem of smelting iron with coke was solved, cast-iron tram lines first used, the first cast-iron bridge erected, and some of the cast-iron cylinders made for Watt's engines. The blast furnace made its appearance in Shropshire about the middle of the sixteenth century, and from 1707 until 1791 the three Abraham Darbys in succession reigned over the Coalbrookdale works.

The Crowleys began as ironmongers in Greenwich and in London, and then became manufacturers of hardware in Durham. The firm was in existence for 170 years, and the picture of the works at Winlaton, where edge tools, files, anchors, nails, spades, etc., were made in very large quantities, is one of a community somewhat resembling that of a great religious house. Innumerable rules were laid down to encourage and admonish, courts of arbitration met at stated intervals, the children were educated, the sick doctored, and the infirm pensioned. Working hours were from five in the morning until eight at night, and curfew rang at nine o'clock. The instructions went so far as to provide for the assistance of those who, by reason of "folly, weakness or extravagance," have had recourse to the pawn shop. Sir Ambrose Crowley died in 1713, a very wealthy man. He had been an alderman and sheriff of the City of London, but Mr. Young's paper shows that he is entitled to be considered the pioneer of industrial welfare work. He made a very remarkable experiment, and the principles laid down by him sufficed for guidance for more than a century.

Our Bookshelf.

The Rigid Airship: a Treatise on the Design and Performance. (The Specialists' Series.) By E. H. Lewitt. Pp. x+283. (London: Sir Isaac Pitman and Sons, Ltd., 1925.) 30*s.* net.

THE airship in aeronautical text-book literature has received but scant attention in the past. Aeroplane and seaplane design and the theoretical problems associated with them compose the subject matter of such works, while airships are dismissed in a few meagre paragraphs under the general heading of "lighter-than-air craft." There is no special reason for this other than that the airship has almost consistently been regarded as the step-child of officialdom and certainly not to be encouraged by any consistent policy of construction and development. Yet, regarded as a scientific problem, the design of the rigid airship, as the present work proves, presents a problem in a type of structure which has not previously occurred in engineering and consequently gives rise to a crop of fresh problems both on the aerodynamic and the structural sides.

The present work is confined to the question of design on the structural side. The earlier chapters analyse the forces on the airship in so far as they affect this question. The types of girders and struts used and the elastic properties of which they are composed are described in Chap. iv. The next two chapters treat of the beam stresses and the temperature stresses in the hull. The author then passes on to consider the tensions in the wiring—transverse, circumferential, and diagonal—and the longitudinal girders. The treatment is completed by a discussion of performance and a detailed analysis of design in a special case.

The author has throughout adopted the sound method of approaching each problem mathematically and comparing the results so obtained with actual experiment. In this respect the treatment is excellent. If a criticism might be offered, it is that the author has tended to keep rather closely to the methods developed in his own contributions to the subject, so that the work of other investigators is scarcely accorded sufficient prominence; otherwise a most satisfying book.

The British Journal Photographic Almanac and Photographer's Daily Companion, with which is incorporated "The Year Book of Photography and Amateurs' Guide" and "The Photographic Annual," 1926. Edited by George E. Brown. Pp. 848+32 plates. (London: Henry Greenwood and Co., Ltd., 1926.) 2*s.* net.

As this is the diamond jubilee issue of this well-known publication, the editor has considered it a suitable time to make several improvements in it, though a cursory glance shows that it is similar to previous issues in the general nature and arrangement of its contents. There are three notable changes in addition to the use of a rather clearer type. It is no longer an almanac except in title, for it contains nothing of the nature of an almanac or calendar. What was originally subsidiary matter has increased so much that the volume is now a general practical guide and record of progress, and in due time, we suppose, the main title will indicate this. For many years a substantial part of the matter other than the advertisements was a collection of short articles from many contributors giving their experiences and suggestions. This section served its purpose at the time, but changing circumstances rendered it advisable to discontinue it. This year there is tendency to return to it; but the five articles are rather of the review or generally instructive character than of a personal nature. The history of the "Almanac," with a reproduction of the first, which was a wall sheet calendar with a few useful items of information in the margins, is of value from a historical point of view. The editor on "Amateur Cinematography," Mr. T. L. J. Bentley on the use of a hand-camera, and Mr. J. W. Purkis on "Rational Time Development" are authoritative articles on matters of present-day interest. As a celebration of the jubilee the volume includes thirty-two excellent photogravure reproductions, twenty-five of which are from the Paris Salon of Photography.

Electrical-Machinery Erection. By Terrell Croft. Pp. ix+314. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 15*s.* net.

MR. CROFT is concerned with the mechanical features of electrical machinery installation. The average young engineer when he has finished his college training knows little of the mechanical operations that have to be performed between the unloading, for example, of a heavy motor generator set, from the car to its final fixing and aligning in its operating position. As a rule, he allows himself to be guided by the foreman, who generally does everything by a cut-and-dried method. The methods of arranging the slings and of bracing the apparatus prior to lifting he learns from the workmen. The methods learnt in this way are unsuitable in certain cases, and the young engineer is too often thrown on his own resources, sometimes with unfortunate results. We therefore welcome this book, as it should prove useful to every engineer engaged in erecting work. There are 334 excellent illustrations, showing not only the correct methods, but also commonly used incorrect methods, of performing necessary mechanical operations. A section of the work is devoted to "mechanical maintenance," particular attention being devoted to the upkeep of the bearings.

The Dynamical Theory of Gases. By Dr. J. H. Jeans. Fourth edition. Pp. vii + 444. (Cambridge: At the University Press, 1925.) 30*s.* net.

THE intervals at which new editions of this valuable treatise are called for grow shorter, testifying to the continued—in fact, growing—interest of students and investigators in the subject, and to the importance of the service rendered by the author in presenting it so admirably. The second edition, of 1916, was different in important respects from the original work of 1904, the quantum theory having in the interval offered a way of escape from the difficulties surrounding the theorem of equipartition of energy. In the third edition, of 1921, the account of the quantum theory was extended. In the present issue a few recent papers on the kinetic theory are duly remarked on, either in the text or in footnotes, but no important changes are made.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Law of Inertia for Radiating Masses.

RADIATION of amount δE, lost by a body, diminishes its effective mass, on Maxwellian principles, by $\delta E/c^2$: and some perplexity is apparent in recent discussion as to how this tells on the dynamical inertia of a planetary mass. According to the Newtonian doctrine, it is the rate of change of momentum mv which must be equated to the extraneous gravitational or electric force acting on the body: and this principle was taken over by Einstein, in extended fourfold form and in concert with relativity, as the key to his brilliant tentative explorations towards a closer view of gravitation. But

$$\frac{d}{dt}(mv) = m\frac{dv}{dt} + v\frac{dm}{dt};$$

so that if the mass is diminishing by radiation, conservation of momentum seems to demand acceleration of velocity of a body isolated and so free from external force. Yet the doctrine of relativity asserts that no standard can exist on which to measure such change of velocity, whether of translation or rotation: such a conclusion therefore would contradict relativity. On this ground it is claimed that the applied force must be equated, following Dr. Jeans, to $m\frac{dv}{dt}$ and not to $\frac{d}{dt}(mv)$. Yet the latter form is based directly on a very keystone of relativity. One way out of the apparent paradox would be to postulate a frame in the ether with reference to which the velocity of an isolated body could be measured: this would institute an exception to accepted doctrine widely verified. Prof. E. W. Brown (*Proc. U.S. National Academy*, 1926, p. 2) appears to be troubled, and naturally so, by uncertainty as to which formula to adopt with a view to studies on cumulative long-range effects of radiation in dynamical astronomy.

It seems well worth while, in this connexion, to direct attention to a classical memoir by the late Prof. Poynting (*Phil. Trans.*, 1903) on "Radiation in the Solar System" and to his other investigations, theoretical and experimental, on pressure of radiation, in which astronomical effects are considered. In particular, he revealed (by indirect argument) what amounts to the Bradley aberration effect in pressure of extraneous radiation on a moving body: and he showed that it produces a retarding force that would in times quite short geologically suck all small bodies such as cosmical dust revolving steadily round the sun, into that luminary. This is doubtless the explanation, as he remarked, why the celestial spaces are so transparent. Incidentally it may perhaps require that the cosmic dust that reflects the zodiacal light should have some source of replenishment.

This, however, is not directly connected with the inertia question. But in the reprint of Poynting's "Collected Papers" (Cambridge University Press, 1920), the question of the effect of diminution of inertia by radiation had to be gone into, in the notes and corrections then appended to the work, as on the face of things it may be quite comparable in importance (for large masses) to the deflexion of the radiation pressure by aberration. The explanation proceeds on the principles of Maxwell's great "Treatise" of 1873, without any reference to relativity. It is in effect verified (pp. 434, 754-7, referring back to "Math. Congress Report," Cambridge, 1912) that the momentum of the whole system, matter *plus* radiation, is conserved, as it ought to be, in the absence of any extraneous force; but a part of its gradient equal to $v\frac{dm}{dt}$, where $\delta m = -\delta E/c^2$, is momentum carried away by the radiation δE issuing from the system, by the mechanism of radiation pressure, while it is the remainder $m\frac{dv}{dt}$ that is to be equated to the extraneous force, which acts on the material system itself, not on the radiation that has escaped from it.

This seems to be the adequate practical settlement of this question, and may, it is hoped, encourage Prof. Brown to proceed with closer astronomical investigations in improvement of Poynting's pioneer indications: though how far it consorts with an extreme relativist position is a different question. But Poynting's retardation by the aberration influence on pressure of radiation will also have to be taken into account in the cosmical problem of the evolution of the orbits of a double star, as probably of the same degree of importance as change of effective mass by loss of radiant energy.

In Poynting's own special problem there is no change of mass (other than that involved in high velocity in accordance with Least Action), as the loss by radiation is made good by absorption from the sun.

JOSEPH LARMOR.

Cambridge, February 9.

The Structure of Molecules.

WITHIN the past few months there have appeared several papers on band spectra containing results of great theoretical significance. Taken in connexion with the data given in my letter to NATURE of February 13, p. 229, on the energy levels of the carbon monoxide molecule, they appear to indicate a comprehensive analogy between the electronic energy levels of molecules and of atoms. The additional evidence furnished by the rotation and vibration of molecules then makes possible conclusions as to the actual paths of the valence electrons in molecules, and these results may in turn be used as evidence as to the structure of atoms.

Some of the investigations leading up to this situation are as follows. Mulliken (*Phys. Rev.*, 26, 561, 1925) has shown clearly the existence of two types of multiplicity in the band spectra given by diatomic molecules. One type is essentially a function of the rotation of the two nuclei about their common centre of gravity, and has no counterpart in atomic structure. It is not concerned in the present discussion. The other type is essentially independent of rotation and of vibration, and, as Mulliken has pointed out, leads to multiple electronic energy levels in the molecule which may be correlated with the multiple levels of atoms. Thus in the "odd" molecules CO^+, BO, CN, and NO, there is a double level which may be designated as a double "*p*" level. Mulliken (*Phys. Rev.*, 26, 1, 1925) has found such a double level also in the alkaline earth halides, and has noted that the doublet separation is of the same order of magnitude as in a certain "corresponding" atom, having the same number of valence electrons. Mecke (*Naturwiss.*, 13, 698 and 755, 1925) independently pointed out certain analogies between BO, CO^+, CN, and N_2^+, and investigated also the alkaline earth halides. For these latter he applied the Landé formula for the doublet separation in the alkalies, and thus obtained an "effective quantum number," and an "effective nuclear charge," for the orbit of the valence electron of the molecule. The result indicated considerable "penetration" of the electron. Hulthén (NATURE, 116, 642, 1925) found doublet separations in HgH, CdH, and ZnH, which are of the same order of magnitude as a certain p separation in Hg, Cd, and Zn.

In the present communication I am considering particularly diatomic molecules with two atoms of more or less equal mass, such as CO, CO^+, N_2, N_2^+, NO, CN, and BO. For such molecules Mulliken has assumed that each atom retains its own K electrons, but that the remaining electrons are held in common by the two atoms, and may have much the same arrangement as in atoms. In the above molecules there are thus eight electrons with a rare gas configuration, plus one, or two, or three "valence" electrons, and the molecular structure is to be compared with one-, or two-, or three-valent atoms In CO^+, CN, and BO there are, in addition to the double p level, two single electronic levels, one above and the other below the p level, and Mulliken suggested that they might be called s levels. This suggestion resulted from an analysis of the character of the band systems associated with the s-p, s-s, and p-s transitions. (The reader is reminded that an entire system or group of bands corresponds to an electron transition between two major electronic levels, and hence to a single "line" or, more generally, to a single "multiplet" of atomic spectra. All three of the transitions just noted are known in CO^+ and BO, with the s-s transition giving the strongest band system. See Birge, NATURE, 116, 207, 1925, and Mulliken, *Phys. Rev.*, 25, 259, 1925.)

Let us now consider the actual "term" values of the electronic energy levels of molecules, defined just as in the case of atoms as proportional to the work required to carry the valence electron from the level in question to infinity. There are as yet but little data for such calculations, accurate values of the ionisation potential of molecules being especially scarce. CO, N_2, and H_2 are, however, three sources of possible information. The designation of successive levels as X, A, B, C, X', A', etc., as used in my letter on carbon monoxide, is retained here.

Using X'-X in carbon monoxide as 14·2 volts, as discussed in this letter, and writing $\nu = R/D^2$, where R is the usual Rydberg constant, and D the "denominator" of the term ν, one obtains for the X, A, and B levels, values of D of 0 98, 1·48, and 1·97. In this case all three terms are single, and since carbon monoxide should "correspond" to magnesium, the results immediately indicate that these energy levels are really the $1S$, $1P$, and $2S$ levels of the molecule, where $1S$ and $2S$ fit into a *Rydberg formula*. Sponer (*Zeit. f. Phys.* 34, 622, 1925) has noted from my diagram of the energy levels of N_2 (NATURE, 114, 642, 1924) that A, C, and D fit a Ritz formula, giving very closely the observed value of the ionisation potential. I now find that A is a triple level of spacing approximately 20 and 42. The spacing of the $1p_{123}$ level of the "corresponding" atom Mg is 41 and 20. The C level of N_2 is undoubtedly triple, with intervals roughly of two units. The $2p_{123}$ level of Mg has a spacing probably of 4 and 2. For the $1p_{123}$ level in N_2 the order of spacing is inverted, as compared to that for the atom, and Mulliken has noted, from the relative intensities in the molecular double p level, that it also is "inverted."

In the helium molecule it has long been known that there is a set of electronic energy levels given by the ordinary Rydberg formula (Fowler, *Proc. Roy. Soc.*, A, 91, 208, 1915; see also Curtis and Long, *ibid.* 108, 513, 1925), and in the hydrogen molecule there is a similar set of levels, running to the limit 16 68 volts, which is a reasonable value of the ionisation potential of H_2. This interpretation of the Olson and Glockler results (*Proc. Nat. Acad. Sci.*, 9, 122, 1923) is due to Olson (see Urey, *Proc. Nat. Acad. Sci.*, 11, 618; 1925). Hence in *all* molecules where data are available, we find series of energy levels fitting at least approximately into the customary formulæ of *line spectra*. It therefore seems to me that the time has come to make the following generalisation, which is admittedly based on data only for a few diatomic molecules, confined to definite types.

The energy levels associated with the valence electrons of molecules agree in all essential aspects with those associated with the valence electrons of atoms. The molecular levels may be designated s, p, etc., and levels of the same letter-designation may be represented by the usual formulæ of line spectra, and have the same multiplicity as in the case of corresponding atoms. The actual spacing in the multiple levels is often roughly the same as for the "corresponding" atom. Further examples of this are: for $1p_{12}$ of CO^+, 126, as compared to 91 5 for Mg^+; for the *stable* $1p_{12}$ level of NO, 135, and for the corresponding atom Al, 112. This interpretation of Dr. Sponer's energy levels of NO (NATURE, January 16, p. 81) is due to Mulliken (private communication). In other cases there is no numerical agreement, as in the $1p_{12}$ level of CN and BO ($\Delta\nu = 54$ and 126, compared to 17 for Na). Further points of difference between atoms and molecules are: (1) the multiple molecular levels are "inverted"; (2) s to s transitions in molecules are not only not prohibited, but are especially prominent.

If now the systems of energy levels of the molecule and of a "corresponding" atom are essentially similar, the electronic structure responsible for the two systems must also be essentially similar, as already suggested by Mulliken and by Mecke. But the band spectra data give additional direct evidence as to the character of this structure. Thus in the molecules CO, CO^+, NO, CN, and BO, the frequency of vibration of the dipole for the p state is always *less*, and consequently (from a known invariable relation) the moment of inertia *greater*, than for the s state above as well as below it. Now in an atom, according to current theory, the "penetration" of the electron in the s orbits is greater than in the p orbits. If then the valence electron (or electrons) of the molecules here considered moves in an elongated path which penetrates to the region *between* the two nuclei, the greater penetration of the s orbit would lessen the repulsion of the two nuclei and thus produce a smaller moment of inertia. This gives a picture of the valence electron as one moving in a path which projects beyond those of other electrons, and so gives this electron its valence character, but also penetrates the region between the two nuclei and so plays a definite rôle in determining the strength of the chemical bond. I think that band spectra can thus give evidence as to the character of electronic orbits, the mere existence of which some investigators still seem to doubt.

The above conclusions allow a rough computation of the ionisation potential of CO^+, N_2^+, and similar "odd" molecules, and the results raise many interesting points for which there is no space in the present communication. In particular, the *total* work to remove *both* valence electrons from CO or from N_2 is equal, within the large limits of error, to that required to remove both electrons from Mg, but the work necessary for the removal of the first electron (and consequently for the second) in the case of the molecules is quite different from that for the atom. So far as I can see now, none of the results are inherently unreasonable or in conflict with the present experimental data, and I hope to consider them in detail in the full report of this work.

I have had the benefit of consultation with the many persons in this University who are interested in these problems, and also of much correspondence with Dr. Mulliken. I am especially indebted to Dr. Sponer and to Dr. Mulliken for helpful suggestions.

RAYMOND T. BIRGE.

University of California,
December 19, 1925.

Effects of Polarised Light on Bacterial Growth.

DURING recent years certain biochemical effects of polarised light as compared with ordinary light have been brought into prominence by Dr. Elizabeth Sidney Semmens (*Journ. Soc. Chem. Ind.*, 42, 954, 1923; also *Bri. Assoc. Rep.*, 1923). She has shown that the hydrolysis of starch proceeds with greater rapidity in polarised light than in ordinary light of the same intensity, all other conditions being identical

In biological studies of bacteria specially with reference to their pathological and epidemiological significance, heat and various other physical conditions such as humidity, etc., have been put up as factors of fundamental importance. So far as the authors are aware, however, very little attention has been paid to the effects on these aspects of bacterial life of the variations of luminous radiations in Nature. The amount of polarisation of light, as is well known, being subject to marked variations not only from season to season and country to country but also during different parts of the day and night, it occurred to the authors to investigate as to how the bacteria would react to polarised light.

So far preliminary experiments on the growth of *V. Choleræ* and *B. typhosis* (strains obtained from Kasauli) have been tried. The results obtained were so interesting that it was considered desirable to communicate them without delay.

Emulsions of young *V. Choleræ* and *B. typhosis* cultures in Dunham's solution and nutrient broth respectively were prepared and thoroughly shaken in a mechanical shaker. Equal amounts of the uniform emulsions so obtained were exposed for a definite period to polarised and unpolarised light of equal intensity in two compartments of a sterilised optically correct cell ordinarily used with a Rayleigh interference refractometer manufactured by Messrs. Adam Hilger. The source of light for both the polarised and the unpolarised beams was a hundred-candle-power half-watt lamp from which two beams of light were obtained by means of a parallelising device. The polarisation of one beam was effected by interposing a Nicol prism in its path, and the intensities of the two beams were equalised by means of glass plates. To test the intensities of the two beams of light, the deflexions produced in a Broca's galvanometer were compared when a Rubens linear thermopile connected to the galvanometer was placed at equal distances in their paths.

The difference in the turbidity of the two compartments after exposure was taken as an index of the difference in their bacterial content. The turbidities were determined by exposing the two compartments successively to a standard source of light (6-volt half-watt Mazda lamp) for half a minute and measuring the intensities of the light, after passing through the cell, by means of the thermopile and Broca galvanometer arrangements described above. The results so obtained were confirmed by plating out 0·5 cc. of the contents of the two compartments on agar and counting the number of colonies in the two cases after forty-eight hours' incubation at 37° C.

Some of the results are shown in the table below. The observations were made at room temperature

Type of Organism	Duration of Exposure	Deflexions of the Galvanometer.		Colonies on Agar.
		Compartment exposed to polarised light	Compartment exposed to unpolarised light.	
V. Choleræ. 24 hours' growth on agar emulsified in Dunham's solution	2 hours	0·80 cm.	1·10 cm.	
Do.	14 "	0·90 "	2·60 "	
B. typhosus. 24 hours' growth in broth . .	5½ "	0·80 "	1·15 "	Innumerable in both. Distinctly larger number in the case of the compartment exposed to polarised light.
Do.	21 "	0·70 "	1·25 "	

These results suggest that the polarised light favours bacterial life as compared with ordinary light of equal intensity.

What rôle the reactions of polarised light on the binomics of the bacteria—free in Nature, in water and in the body of the carrier—play in the mechanism of their pathogenicity and epidemicity seems to involve large issues and is a subject worthy of consideration. It also suggests problems regarding the reactions of polarised light on the physiological and pathological processes in the body of the host which may throw some light on questions such as the afternoon rise of temperature in normal individuals and in certain fevers. Work on some of these problems is in progress.

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R. B. LAL.

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The Nature of Active Nitrogen.

LE problème de l'azote actif a donné lieu récemment à un certain nombre de travaux. Dans un article récent (*Zeitsch. f. Phy.*, 84, 622, 1925) Dr. Sponer reprenant les premières idées de Strutt, émet l'hypothèse que l'azote actif est de l'azote atomique (voir aussi R. T. Birge, NATURE, 117, 81, 1926).

J'ai déjà montré (*C.R.*, 178, 1966, 1924.—Thèse, Paris, 1925, ou *Ann. de Phy*, sept. 1925) que cette explication des propriétés chimiques et physiques de l'azote actif est la plus simple et la plus logique. Il semble qu'une seule difficulté fasse hésiter les spectroscopistes à admettre l'hypothèse atomique. Au cours de l'activation et de la neutralisation, l'azote n'émet que des spectres de bandes à l'exclusion de tout spectre de raies. Or il est généralement admis que les spectres de bandes ne peuvent être émis que par des molécules polyatomiques. La présence d'atomes dans l'azote actif paraît, dans ces conditions, assez peu vraisemblable. Ainsi s'explique que plusieurs physiciens, à la suite de Saha et Sur (*Phil. Mag.*, 48, 431, 1924) n'aient voulu voir dans l'activation de l'azote qu'une transformation, sans dissociation, de la molécule diatomique en une forme métastable de niveau énergétique élevé.

Or des mesures précises de largeurs de raies faites par Hamy (*C.R.*, 157, 142, 1913) et par moi (*C.R.*, 178, 474, 1924, et *loc. cit.*) ont montré que, si le premier groupe positif de l'azote est effectivement émis par la molécule diatomique de masse 28, le 2^e groupe positif et le groupe négatif de l'azote sont certainement émis par l'atome de masse 14. Le 2^e groupe positif est précisément celui qui prédomine dans la décharge électrique où l'azote est activé. Je sais que cette attribution de spectres de bandes à des atomes paraît scandaleuse à la plupart des spectroscopistes, mais, dans le cas particulier du 2^e groupe positif de l'azote, elle s'accorde avec la plupart des propriétés de ce spectre.

Elle s'accorde avec l'ordre d'apparition des différents groupes de bandes de l'azote. Elle s'accorde avec les valeurs proposées par Sponer (*loc. cit.*) et Duncan (*Astro. Jour.*, **62**, 145, 1925) pour les potentiels d'excitation du 2^e groupe positif et du groupe négatif, et par R. T. Birge et Sponer pour le potentiel de dissociation de la molécule : ce dernier étant inférieur aux deux autres. J'ai montré qu'elle s'accordait également avec les phénomènes lumineux que l'on observe en dissociant dans la décharge électrique les oxydes NO et NO^2 dont la molécule ne contient qu'un atome d'azote (*loc. cit.*) Enfin cette attribution comble une lacune de la théorie atomique de l'azote actif telle qu'elle est exposée par Sponer.

Si les atomes d'azote jouent le rôle essentiel dans les propriétés de l'azote actif où ils doivent dès lors exister en proportion notable, il devient étrange qu'ils ne manifestent leur présence par aucune émission. La même remarque peut être faite à propos de l'excitation des spectres de bandes de l'azote par chocs électroniques telle qu'elle est décrite par Sponer. Le 2^e groupe et le groupe négatif sont émis à des potentiels supérieurs au potentiel de dissociation. Sponer admet que cette dissociation se produit effectivement. Ainsi donc, dans les conditions où ces deux groupes de bandes sont émis, le gaz soumis au bombardement électronique contient des atomes libres, d'autant plus nombreux que, si l'on en juge par les propriétés de l'azote actif, leur vie moyenne doit être beaucoup plus longue que celle des atomes libres d'hydrogène dans les mêmes conditions. Cependant ces atomes, malgré les chocs d'électrons, d'atomes-ions, de molécules-ions, n'émettent aucun spectre de raies, c'est-à-dire, suivant la conception classique, n'émettent rien. Le spectre de raies, le seul universellement attribué à l'atome d'azote, n'est excité que par des potentiels très élevés. Il apparaît de plus en plus comme un spectre d'étincelle d'ordre supérieur, émis sans doute par un atome ionisé, peut-être plusieurs fois, atome dont la structure est dans tous les cas profondément différente de celle de l'atome neutre normal qui existe dans l'azote actif et est détaché de la molécule par un choc d'énergie minimum. Il me semble plus naturel de permettre à cet atome neutre l'émission d'un spectre de bandes que de lui refuser toute possibilité d'émission.

Dès lors le parallélisme est complet entre les phénomènes observés par Wood sur l'hydrogène et ceux observés par Strutt sur l'azote. Pour les deux gaz la forme atomique, chimiquement active, apparaît dans la décharge électrique dès que la densité des chocs suivis de dissociation est assez grande pour que le spectre de l'atome subsiste à peu près seul dans la décharge.

Je me permets de rappeler ici des expériences qui confirment singulièrement la théorie atomique de l'azote actif et qui semblent avoir été oubliées dans les discutions récentes. Angerer (*Phy. Zeit.*, **22**, 97, 1921) a montré que la neutralisation spontanée de l'azote actif est une réaction bimoléculaire : la formation d'une molécule phosphorescente exige la destruction simultanée de deux molécules actives. Dans l'hypothèse atomique cette loi est évidente ; elle me paraît difficile à concilier, sans de singulières complications, avec la théorie moléculaire de Saha et Sur. M. DUFFIEUX.

Faculté des Sciences de Marseille,
Janvier.

Labelling in Public Institutes for the Public.

SIX years' experience of the British public who frequent the Zoological Gardens has given me certain fixed ideas of their requirements, and of their intellectual capacity, which I believe may be of interest to those in charge of museums or any similar public institutions

In 1917 I took over the management of the Insect House, and during the first month, while considering its possibilities and its limitations, I made a particular study of the types of visitors to the gardens, and came to the conclusion that they might be classed under three headings:

(1) The uninformed seeking information, 60 per cent.
(2) The unthinking, 30 per cent.
(3) The instructed and the experts, 10 per cent.

The only possibility of making the Insect House serve the third section was to maintain a supply of rare insects. This is difficult at any time in Great Britain, and during the War was out of the question.

On the other hand, if the activities and any biological facts of interest concerning even common insects could be exhibited in a manner to make them comprehensible to the first and second sections, then the majority of our visitors would be served. For mere exhibits of insects with their names are of no interest to the general public.

It was, however, several months before I learnt how to word explanatory labels, which, of course, are of primary importance. I gave simple lectures in the Insect House 'in the vulgar tongue,' and found that they were listened to with understanding; but when the public were left to obtain information from the labels they would frequently not give themselves the trouble to read them. Pictorial labels were of great assistance, but the wording of the explanatory labels had to be very carefully studied; indeed, after spending many hours in writing labels I have frequently had to re-write them on discovering that the public were not reading them to the end. By many failures I learnt at last that a label to be of service must in the first place be arresting—that is, it must state some interesting matter in the first few words—also that the terms in which facts are conveyed cannot be too simple, and that when any unfamiliar word occurs then the explanation of it must follow immediately. It was a cause of deep satisfaction to me when I discovered members of the working class showing their families or friends round the Insect House *guided by the labels*.

Of recent years much has been done to increase the usefulness of our museums by careful labelling, but it seems to me that much more might be done. When I hear those responsible saying that the public are not sufficiently interested to read labels, I go at once to read the labels myself and draw my own conclusions. I know from experience that the public are ready to be instructed, and actually hunger for instruction; but I think it is not generally recognised how very easily they are discouraged if it means studying what is to them a new language in order to obtain information. L. E. CHEESMAN.

Zoological Society,
Regent's Park, London.

Is the American Slipper-Limpet (*Crepidula fornicata*) an Oyster Pest?

THE shortage of oysters (*O. edulis*) on the European oyster beds has led to the introduction in many places of American oysters, on which the American slipper-limpet (*Crepidula fornicata*) frequently occurs. Oyster-cultivators in various parts of Europe are therefore becoming interested in the possible effects of introducing the slipper-limpet on their beds, so that it has become a matter of economic interest to know the results to date of the introduction of this animal on English oyster-beds since its arrival about 1880 (see Orton, *Proc. Roy. Soc.* B. 91, 1909).

The American slipper-limpet (*Crepidula fornicata*) is undoubtedly regarded as a great pest on the oyster beds in the Thames Estuary at the present time for the following reasons:

(1) It has spread so rapidly and thrived so well in that locality that it is possible to dredge 20 tons a day on some grounds, actually occupied by oysters. In a pit adjacent to—but not actually a part of—the oyster beds the writer took in July 1923 in a few minutes' haul of the dredge 2226 limpets weighing approximately 26 lb. On all grounds it has increased the labour in dredging, while adding only slightly or not at all to the income of the oyster-producer.

(2) The limpets attach themselves in piles or chains on the oysters, which have therefore to be cleaned of limpets as well as barnacles, etc., before sending them away from the beds.

(3) It is impossible to remove Crepidula entirely from the beds, once it is established on the ground, as it has a free-swimming larva—like the oyster—and in addition changes its sex from male to female so that every individual may breed as a female (*loc. cit.*). Moreover, spawning occurs in England from about March to November, and females may spawn more than once in a season.

In favour of Crepidula, it may be said:

(1) That it is not an enemy of the oyster but a competitor for space and food, like sea-squirts, various bivalves, and other plankton-feeding animals.

(2) That where Crepidula occurs in abundance it can be dredged in the normal routine of work, and the shells easily accumulated in great piles and cleaned and bleached to serve as cultch for catching oyster spat. On some beds Crepidula is beginning in this way to pay some of its debts to the oyster-producer.

There can be no doubt, however, that unless Crepidula can be utilised as food—in a small way its shell is utilised in England when crushed with oyster shells as chicken food—it is a great nuisance to the oyster-cultivator. No serious attempt has been made in England to use the slipper-limpet as food, but it is probable that if Crepidula occurred in quantity in France it would be so utilised, and acclaimed as an undoubted benefit.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, January 20.

Photo-electric Polarimetry.

As the use of selenium cells and photo-electric devices is engaging the attention of several workers, a brief account of an application to the polarimeter due to one of our research students—Miss Winifred E. Dickes—may be of interest.

A long series of experiments has led to a simplified arrangement as follows. The apparatus in essentials consists of a spectrometer, for the collimator of which is substituted a polarimeter without eyepiece or half-shadow device, but having a slit over the polariser diaphragm and an electrical photometer behind a slit in the eyepiece of the telescope. An additional eyepiece is placed at right angles to the axis of the telescope for observing the line of the spectrum employed. Half of the field of this eyepiece is fluorescent, for convenience in setting when making determinations in the ultra-violet regions.

The photometer used is a selenium or alkali metal cell, and valve amplification is being tried.

The peculiar novelty of the method is the way in which the observations are taken. A quantitative measure of the light intensity is obtained. Two positions are found, about 90° apart, which give the same current. The mean of the two readings so found gives an accurate value for a minimum or maximum, according to choice, although the minimum as a rule is slightly to be preferred.

The readings 90° apart are taken repeatedly and are averaged in the same way as pointer readings are used in weighing. With a selenium cell, these observations are made at fixed time intervals to allow for the characteristic small secular variation in the current.

Since there is no half-shadow device, the whole of the light can be utilised by the photometer. A magnified image of the polarimeter slit is used for the photometer, in order that a larger (that is, more sensitive) selenium cell may be used.

At the end of 1924, with a rough arrangement, an accuracy had been obtained of 0·01° in the red end of the spectrum and 0·1° in the violet. The work was then interrupted by illness. It is now being resumed, and there is reason to hope that a considerably greater accuracy may be obtained, when a paper will be published.

It is proposed also to investigate two possible extensions, namely, the direct use of the apparatus for absorption measurements, and its adaptation to an automatic or recording polarimeter.

JOSEPH KENYON.

Battersea Polytechnic,
London, S.W.11,
February 2.

Wordsworth's Interpretation of Nature.

THE introductory lines which appear in the complete collection of Wordsworth's poems crystallise, with such singular fitness, the point of view so ably expressed in the supplement to NATURE of January 16 that I think it is important to direct attention to them:

> If thou indeed derive thy light from Heaven,
> Then, to the measure of that heaven-born light,
> Shine, Poet! in thy place, and be content:
> The stars pre-eminent in magnitude,
> And they that from the zenith dart their beams,
> (Visible though they be to half the earth,
> Though half a sphere be conscious of their brightness)
> Are yet of no diviner origin,
> No purer essence, than the one that burns,
> Like an untended watch-fire, on the ridge
> Of some dark mountain; or than those which seem
> Humbly to hang, like twinkling winter lamps,
> Among the branches of the leafless trees;
> All are the undying offspring of one Sire:
> Then, to the measure of the light vouchsafed,
> Shine, Poet! in thy place, and be content.

The lines in parenthesis surely indicate once more the possibility that Wordsworth might easily have become a man of science, whilst the following lines display, as effectively as anything in the body of his works, that intense spirituality of the poet's vision, the *particular* quality of which is unique among the great English poets. Can there be any lover of Nature but has felt the influence of that star which scintillates above the dark line of the hills, or who does not recognise this imagery to symbolise the whole beauty of a sparkling winter evening—when, may be, one is walking along a country road over the crackling puddles. But there is, further, local colour behind the imagery in question. I can never read the line and a half beginning with "Like an untended watch-fire" without experiencing a vivid sense of the stern background of the Cumberland fells, and of the various moods of that northern climate to which the lakeland hills are so exquisitely attuned. Had Wordsworth been reared in some other part of England equally beautiful, only different, would this have been reflected in the general character, apart from local concrete imagery or topographic detail, of his poetry? To some extent one may, I think, infer this; but in such deep aspects of human geography it is necessary to exercise the utmost caution, for we know little of the influences which affect the human spirit or in what direction they may act.

L. C. W. BONACINA.

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January 31.

The Arabic Text of Avicenna's "Mineralia."

THE production of spurious books on alchemy, claiming to be translations from the Arabic, was undoubtedly practised on a large scale in the Middle Ages. An unfortunate result has been that modern scholars are inclined to view with grave suspicion all Latin chemical treatises which pass under the names of Arab authors, and have thus inevitably rejected many books which are genuinely what they profess to be. An interesting case in point is provided by the tract entitled "Mineralia," ascribed to Avicenna and printed in Manget's "Bibliotheca Chemica Curiosa," 1, p. 636, and elsewhere. This was rejected as a forgery by Kopp ("Beiträge zur Geschichte der Chemie," 3, p. 56) and others, though Hoefer ("Histoire de la Chimie," second edition, 1866, 1, p. 345), with a truer insight, regarded it as genuine.

A careful study of the tract convinced me that Hoefer was right, and after a prolonged search I was fortunate enough to discover the Arabic text. The "Mineralia" is, in fact, a close translation of certain sections of a work by Avicenna which is undoubtedly authentic, namely, "Al-Shifā'," manuscripts of which occur in the British Museum and many other libraries. Since Avicenna's views on alchemy (he was a pronounced opponent of those who maintained the possibility of transmutation) exerted a great influence upon contemporary scientific thought, it has been considered desirable to publish the Latin and Arabic texts together with an English translation; this edition is now in course of preparation.

E. J. HOLMYARD.

Clifton College, Bristol,
February 7.

Intrinsic Brightness.

THE intrinsic brightness of sources of light seemed at one time to be a simple matter, namely, 2½ candle-power per square inch for a candle-flame, 200 to 450 for a carbon filament lamp, 1000 for a tungsten vacuum lamp, and 80,000 to 110,000 for an open electric arc. The areas were the simple measured projected areas of the surfaces.

The question arises, however, whether those areas should be taken. The apparent diameter of a modern intensely incandescent filament is greatly increased by irradiation. The fine spiral filament of a gas-filled lamp appears, visually, to be a very thick filament. The bunch of straight up and down filaments of a tungsten vacuum lamp appear, at a little distance, to be a uniform incandescent patch of many times the area of the filaments, and would be indistinguishable from a flat uniformly incandescent surface of the same apparent area. Considerations of comfort, to say nothing of possible injury to the eyes by too great intrinsic brightness, have become important. Opal glass bulbs absorbing an unimportant fraction of the light, are being used for the purpose of increasing the apparent area, and thus reducing the intrinsic brightness. The definition of this quantity appears to be one for physiological or ophthalmic consideration, rather than for simple physical measurement. If the apparent area is to be taken, how is it to be measured? Is it subjective or objective?

A. P. TROTTER.

Greystones, Teffont,
Salisbury, February 5.

Neglected Early Scientific Instruments and Apparatus.

LIKE many other readers of NATURE, I have been greatly interested in the extracts from the early records of the Royal Society and the Philosophical Society at Oxford which have been appearing in its columns. Those recently published illustrate and supplement Mr. R. T. Gunther's "Early Science at Oxford" and bring into relief the pioneer work done in every department of experimental science by graduates of Oxford and Cambridge during the seventeenth century.

As an old curator I know how many unregarded "rarities" are still stowed away, neglected and forgotten, in the cupboards and corners of every local museum throughout the country. I would suggest to those in charge of such museums that they should look through their "lumber" to ascertain whether there are any pieces of scientific apparatus which should again see the light. This was done with brilliant success at the colleges in Oxford in 1919, and the Ashmolean has, in consequence, come into its own again. I feel sure that a more extended search would lead to even greater results, and if the finds were reported to Mr. Gunther he would make a note of them, and it might be possible to gather them together as a loan exhibition.

D'ARCY POWER.

Cirsium eriophorum.

IN NATURE (November 14, p. 711) Mr. Stuart Thompson alludes to the woolly-headed thistle—*Cirsium eriophorum*—being found at Chewton Keynsham, and remarks that it was from specimens gathered there in 1922 that Dr. Petrak named it sub-sp. *britannicum*. As a matter of fact, Dr. Petrak monographed the genus in 1912 ("Bibliotheca Botanica," Heft 78, Stuttgart), which I reviewed in the *Report of the Botanical Society and Exchange Club*, 361, 1913. There Petrak describes seven subspecies, and he chose an inept name (*Cirsium britannicum*), since *eriophorum* is limited to England (Sibbald's Scottish record was erroneous), and there was already *C. britannicum* of Scopoli, but that is *heterophyllum* and therefore invalid. So far from the subspecies being due to a Somerset specimen, Petrak's details of his drawing are made from a Huntingdonshire plant.

G. CLARIDGE DRUCE.

Oxford.

Eclipse Observations in Sumatra, January 14, 1926.

By Lieut.-Col. F. J. M. STRATTON.

EXCEPT for an Italian expedition to the east coast of Africa, all the astronomical expeditions to observe the eclipse of January 14 stationed themselves in Sumatra. A Dutch expedition under Dr. van der Bilt, with Prof. Pannekoek, Dr. Moll, and Dr. Mynnaert, was at Talangbetoetoe on the central line, near Palembang. Its programme was mainly spectroscopic and spectrophotometric—the distribution of gases in the layers of the corona being a special problem attacked. Most unfortunately, this station was clouded out completely.

FIG. 1.—Mr. C. R. Davidson, with the 10-foot camera and 40-foot objective prism camera.

A party from the American Naval Observatory, basing the choice of station on experience from the 1901 eclipse in Sumatra, was established at Kepahiang, a station in a high valley amongst the mountains which form the backbone of Sumatra. This party consisted of Capt. Littell, Dr. Peters, Dr. Kellars, Lieut. Ransford of the U.S. Naval Observatory, with Dr. Anderson, of the Mount Wilson Observatory. The party was assisted by a detachment of sailors from the U.S. Navy. A telescope of 70 ft. focal length was erected for direct photographs of the corona, and the programme included grating spectrograms with a moving plate of the flash and of the corona. Unfortunately, the sky at Kepahiang only cleared for the last seventy seconds of totality, but a curtailed programme was carried out successfully. The sky had been clear two minutes before totality, but a passing cloud robbed the observers of the first two minutes of totality.

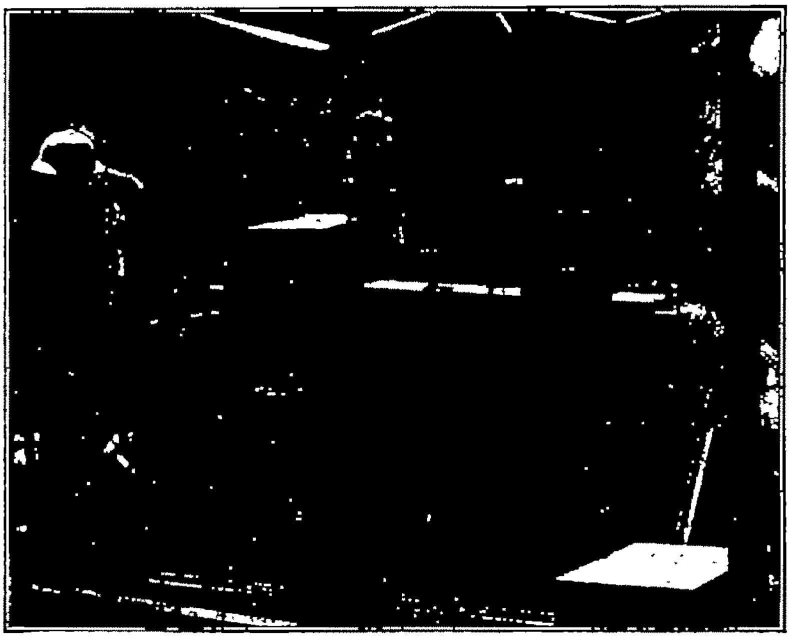

FIG. 2.—Mr. Z. A. Merfield, with spectrophotometric equipment.

At Benkulen, on the south-west coast, three or more expeditions placed themselves. The German expedition under Dr. Freundlich consisted of Prof. Keinle, Dr. von Klüber, and Dr. Mollet. Prof. Voûte, of the Lembang Observatory in Java, Mr. Kerkhoven, and Dr. Knol also joined this party. The programme was mainly the Einstein problem with some spectroscopic work as well. The equatorial telescope taken to Christmas Island in 1922 was used again, and in addition two horizontal telescopes, fed by the same cœlostat and giving simultaneously the sun's field and a second star field, were in use. The sky near the sun was clear throughout totality save for slight cirrus cloud passing over the sun, but the complete programme, including all the comparison plates, was carried out, and it is hoped that the required stars figure on the Einstein plates, and that Prof. Freundlich's continued ill luck at eclipses has ended happily. Attached to this expedition, but available for the other parties at Benkulen, was a field workshop under Mr. Verhoeff.

The American expedition from Swarthmore College was also at Benkulen. Prof. Miller was the leader of the party, and his consistent good luck at eclipses held once more. With him was Prof. H. D. Curtis from

Allegheny, Dr. Marriott, Mr. Dominick, Mr Wilson Powell, Mr. A. Rubel, and Dr. D. B. McLaughlin. Their programme included the Einstein problem, photographs of the corona with a 63 ft. tower telescope, interferometer measurements of the wave-length of the green coronal line, objective grating spectrograms in the infra-red, and colour photographs. The early development of their plates showed general success over the whole programme. Another expedition, camped in the same field, came from Harvard under Prof. Stetson, with whom were Dr. Coblentz, Mr. Weld Arnold, and Mr. W. A. Spurr. Their programme was mainly photometric, and was partially spoiled by the slight haze present in the sky. Capt. Harris, of the U.S Signal Corps, also joined the American expedition with a cinema camera with which he hoped that he had been successful in photographing the elusive shadow bands as well as the whole eclipse.

Fig 3.—Prof. Freundlich's Einstein camera.

The expedition sent out by the Joint Permanent Eclipse Committee of the Royal Society and the Royal Astronomical Society consisted of Mr. C. R. Davidson and Lieut.-Col. F. J. M. Stratton. There joined the party as volunteers Dr. F. W. Aston, Col. J. Waley Cohen, Mr. E. G. Barton, and Major R. G. R. Davies. The expedition was very appropriately and most happily given accommodation in the old British fort—Fort Marlborough—built more than two hundred years ago and now the barracks of the native police. At this station the sun was absolutely clear during the whole of totality, though there was thin cirrus cloud in the immediate neighbourhood of the sun—cloud which passed over the sun during totality for the American and German expeditions less than half a mile away. The main programme was spectroscopic, both the corona and the flash being examined in the extreme infra-red and ultra-violet. Objective prism spectrograms were also obtained of the flash and of the corona in the photographic and visual regions.

Fig. 4.—Prof. J. A. Miller's 63-foot tower telescope with the Einstein telescope in foreground.

At the time of writing, only part of the plates have been developed, but they are sufficient to show that the expedition has been generally successful in its programme. Mr. Barton's programme was mainly photometric, his intention being to measure the total intensity of light from first to last contact; unfortunately, just at the commencement of totality the recording tape broke through a flaw in the paper, an accident which robbed his work of its most important phase.

The British expedition was joined by Mr. Z. A. Merfield, of the University of Melbourne, who was equipped with a moving plate grating spectrograph, a battery of eight cameras with different colour filters to study variation in the corona, and a moving plate colour filter photometer. The instruments were mounted on a polar axis and were all set up and adjusted in time, though owing to a series of accidents they did not arrive until eight days before the eclipse. Here again, general success is indicated by the plates so far developed, and a useful contribution promised to the question of the distribution of solar vapours in the higher chromosphere. Mr. Bridges, of the *Melbourne Herald*, was also attached to the British party as a volunteer, and a cinema camera of his was used with one of Mr. Merfield's parabolic gratings to get a timed series of photographs of the spectrum at the second and third contact. This instrument was worked by Capt. Akkersdyk, who was in command at the Fort and who helped the British expedition by every means that lay in his power. The photographs illustrating this article were taken by Mr. Bridges.

The choice of Benkulen as the site for most of the expeditions was based upon careful observations on cloudiness at eclipse time in previous years. These were made under the direction of Dr. Braak of Lembang, and they proved a useful guide to the visiting astronomers. It should be added that the facilities at Benkulen, and the friendly help given freely on every side, showed how luckily the choice of a site had been made.

The season—the rainy season—was not at all promising, and for the month preceding the eclipse the numbers of fine and cloudy days were about equal. The day of the eclipse itself was cloudy most of the morning, but the sun cleared up for first contact. Thin cloud gathered between first and second contact, but cleared away shortly before totality. Five minutes after the end of totality, the sun was in cloud for the British station.

The corona was intermediate in type, resembling that of the 1900 eclipse in India. There were several very striking prominences on the limb, and the black moon, ringed with bright red prominences and surrounded by the pearl grey corona with its long irregular rays, made a wonderful picture, well worth travelling thousands of miles to see.

Space, Time, and the Universe.[1]

By J. H. Jeans, Sec. R.S.

SOME of us may remember the story of the children who played truant in order to explore the regions where the rainbow ends. After travelling all day, up hill and down dale, they had to admit failure of the most thoroughgoing kind—the rainbow was, to all appearances, no nearer than when they started. Really scientific children might have thought of estimating their rate of approach to the rainbow by measuring the angle it subtended. If they had measured it in the morning it would have been 42° 23′; it would have been 42° 23′ at noon, and again at night it would still be precisely 42° 23′. If they had done this they must have felt that they were the victims of extreme bad luck, for they had clearly seen the rainbow in front of the nearest hill when they started out; could there be some sort of conspiracy on the part of rainbows, hills, and indeed the whole scheme of Nature, to prevent their getting close up to that rainbow?

In the year 1905 the world of physicists was engaged in a pastime which was, in many respects, very similar to that of chasing rainbows. They believed light to travel through an ether with a speed of 300,000 km. a second. If the solar system were travelling through this ether at a speed of, say, 1000 km. a second, it would partially overtake light travelling in the same direction, so that this light ought to appear to travel at only 299,000 km. a second. On the other hand, light travelling in the opposite direction ought to appear to travel with a velocity of 301,000 km. a second. This suggested an obvious means of discovering both the speed and direction of the earth's voyage through the ether—indeed, it was every bit as obvious as the children's plan for exploring the foot of the rainbow. Experiments were designed to utilise this principle and were tried time after time, not in one form only but in many. Time after time experiment gave the answer that the velocity of the earth through the ether was zero, or at least, to put it in another form, which was at that time thought to mean precisely the same thing, the velocity of light relative to the earth was the same in all directions. No doubt it was conceivable that on the occasion of the first experiment the earth really might have happened to be at rest in the ether, but it was quite inconceivable that this should be the case every time; indeed, the earth's orbital motion alone required a variation of some 30 km. a second, and all the experiments were capable of detecting far smaller variations than this.

At first glance it looked as though the earth must be carrying its own private ether about with it, and I suppose this view would have prevailed had it not been for the astronomers, who were ready with an aberration-constant which at once, and, I think, irrevocably, dismissed the possibility of an ether being dragged about with us. Incidentally, this episode provides an often overlooked instance of the services of astronomy to the other sciences and to the growth of knowledge in general. The physicists on Jupiter may still believe that a luminiferous ether exists which follows Jupiter about wherever it goes; the reason is that there are no astronomers on Jupiter to put them right, their permanent blanket of clouds not encouraging this profession.

I forget the end of the story of the rainbow quest, but am prepared to provide an entirely unauthoritative ending. After the children had got completely tired in their bodies and still more completely bewildered in their wits, they rested for a long time, until they encountered a magician. He was not in the least the conventional magician, ponderous of speech and with a long white beard; indeed, he was a young man of twenty-seven, extraordinarily simple and unassuming in all that he said. What he said in brief was this: "I can tell you what is the matter. You have started to chase the rainbow on the supposition that it is a material arch; in actual fact it is all in your own eyes. Gretchen sees one rainbow and Hans sees a quite different one. But if Hans walks up to where Gretchen is standing, he simply changes his rainbow for hers; you don't get any nearer to a rainbow by walking this distance because there isn't really anything for you to get any nearer to. The angle you have been measuring must always stay at 42° 23′; it is fixed there by the unalterable laws of Nature, and children cannot alter these by walking about." As the children were tired, and the young magician had perhaps expressed himself in rather unfamiliar ways, they did not at first quite understand what he meant. But then another magician, whose name was Minkowski, came along, and he made it all seem much simpler; he said it was quite true that each child carried its own rainbow about with it, but that behind the subjective vision of the rainbow was an objective reality consisting of a shower of raindrops. These raindrops were the same for everybody, but out of the whole lot each person's eye selected, or rather the sunshine selected for each person's eye, a small group of drops which appeared to him to form a bright arch. If all space were filled with children standing in different spots, then the aggregate of all the raindrops seen in all the children's eyes would constitute the reality behind the whole phenomenon, a shower of rain. When the second magician put things in this way the children began to understand; they saw that the first magician, whose name was Einstein, had been right.

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[1] Presidential address delivered before the Royal Astronomical Society on February 12, on the award of the gold medal of the Society to Prof. Albert Einstein for his researches on relativity and the theory of gravitation.

I doubt if the Royal Astronomical Society has ever had its medallist introduced to it in so disrespectful a way before, but my little parable may remind you of the way in which our present medallist made his entry into the scientific world, and also of the way in which the scientific world made their entry into the changed universe in which science moves to-day. Time and space, as separate entities, the time and space we wrote about and thought about previous to 1905, have gone, or, as Minkowski puts it, have become shadows, while only the product of the two remains as the framework in which all material phenomena take place. Time and space separately may mean something to us subjectively, but Nature knows nothing of them until they have been multiplied together into a four-dimensional space-time continuum; it is in this that she has set her laws. If I have seemed to treat Einstein's great early work too lightly, I would plead, first, that it has already suffered enough serious exposition, and, secondly, that only really great work permits of being treated lightly, and that it is well to take a chance when it offers itself. But let not the lightness of treatment be thought to imply lightness of esteem for the work. By his single 1905 paper, Einstein started a revolution in scientific thought to which as yet we can see no end, to which, indeed, we can scarcely yet imagine any end. Had he written only that one paper, his position as one of the great figures of science would, in my opinion, have been secure. He would, perhaps, not have been awarded the gold medal of our Society, but that would be because he had not yet become an astronomer.

If the magicians had given the right explanation of the rainbow, then everything the children saw in the rainbow ought to admit of explanation in terms of the ultimate reality provided by the shower of rain. Obviously there would have been something radically wrong if Gretchen had seen a circular rainbow while Hans, standing by her side, had seen a square one; something wrong, too, if Gretchen had said that the colours ran from red to blue as you passed inwards, while Hans said they ran from blue to red. In the same way, if Einstein and Minkowski were right about time and space, there must have been something radically wrong when Isaac Newton had said that every particle in the universe attracted every other particle with a force that varied as the inverse square of the distance, and again when he had said that the path of a planet about the sun was an endlessly repeated ellipse. When the last of these statements, for example, is expressed in terms of the four-dimensional framework which Einstein and Minkowski regarded as the ultimate objective reality, it is found to make sheer nonsense, to be inconsistent with itself. Viewed in that framework, an endlessly repeated ellipse becomes a sort of helical curve, a spiral staircase climbing up into eternity, the projection of which on one particular cross-section is the single ellipse in question. View it at any angle you like and it is still a helical curve, but project it on some other cross-section and you will find that the radius vector relative to the sun no longer describes an endlessly repeated ellipse. In brief, the Newtonian law of gravitation could not be true because it could not be expressed in terms of the ultimate four-dimensional reality in such a way as to be true for more than one person at a time.

When Einstein had this brought to his notice he at once became an astronomer. His task, rather a heavy one for the first piece of work of a young apprentice to astronomy, was to find out what was the matter with Newton's law of gravitation and to put it right. Of course, in a sense, there was not very much wrong: Halley's comet had come back when it was expected, and Jupiter's satellites could be seen every night exactly as the pictures in the "Nautical Almanac" predicted that they ought to be seen if Newton had been right, and all the planets seemed actually to be describing endlessly repeated ellipses except that Mercury wandered very, very slightly from its proper place. Yet, in another sense, there must be everything wrong with a law that did not fit properly into the four-dimensional reality, or at least there was as much wrong as the difference between truth and error, which the true man of science regards as the biggest magnitude with which he ever has to deal. And, just as Kepler, starting from the established error of 8′ in the observed position of Mars had set out "to construct a new theory that will explain the motions of all the planets," so Einstein set to work to construct a new theory which was incidentally to explain the motion of the planets but was destined also to change our whole interpretation of the fundamental significance of these motions.

Every astronomer is familiar with this part of Einstein's work. By 1915 he had found the modification needed in Newton's view of gravitation, and had shown that the orbit of a planet, instead of being the impossible endlessly repeated ellipse, was an ellipse which kept slowly turning round in its own plane. He had also found that the theoretically predicted rate of turning for Mercury was exactly the 43″ a century by which Leverrier had found that the planet's perihelion advanced over and beyond the advance caused by the pull of the other planets. He announced two further physical consequences of his theory. Rays of light passing through a gravitational field ought to be bent by a calculable amount, 0·745″ for light which has just grazed the sun's limb; and spectral lines emanating from atoms in a gravitational field ought to be displaced towards the red, the displacement of lines from the solar photosphere being that corresponding to a velocity of 0·634 km. a second, or, say, 0·008 Å.U. at the cyanogen band, λ3883. Newton had queried in his "Optics" whether rays of light would bend in obedience to gravitational force, but Einstein was the first since Newton to make any definite physical predictions arising out of a theory of gravitation.

Our two British expeditions put the first of these predictions to the test at the 1919 eclipse, and, as we know, brought back the news that the prediction was amply verified. The testing of the second prediction was a more difficult matter, not so much because the small displacement of 0·008 Å.U. was difficult to measure, as because it was masked by bigger displacements of unknown amount. Even to-day the problem can scarcely be said to be solved with absolute finality so far as solar light is concerned, although probably Evershed, St. John, and others have done all that it is possible to do. But the prediction which it was found almost impossible to test by the light of our sun has been tested by the light of one of the faintest of stars. Sirius has, as companion, a smaller and far fainter star which describes an orbit round it. Its effect on the motion of Sirius shows its mass to be 0·85 times that of the sun, and its distance is for all practical purposes the same as that of Sirius. The amount of light it emits is so small that Seares had calculated its radius to be only about 20,000 km. or one thirty-fifth of the radius of our sun. Now Einstein's theory predicts a shift proportional to M/r, so that whereas the predicted shift in the solar spectrum corresponds to a velocity of only 0·634 km. a second, the light from the companion to Sirius ought to show a shift corresponding to a velocity of 20 km. a second, something like a third of an angstrom. Here then was a shift the magnitude of which was suitable for measurement. The measurement was undertaken at Mount Wilson, and the observed shift was found to agree almost exactly with that predicted by theory. This experiment not only established the validity of Einstein's theory of the gravitational displacement of spectral lines, but also showed its usefulness as an instrument to be utilised by the practical astronomer in his everyday work.

The ultimate importance of Einstein's work was not, however, that it gave astronomers new tools for the measurement of stellar diameters, or for the prediction of the position of Mercury; it was not even that it gave the true law of gravitation; it was that it gave a new conception of the meaning of gravitation and of gravitational force. Strictly speaking, Einstein did not amend Newton's law of force; he abolished it. He put something else of a quite different nature in its place, something which was consistent with itself when looked at in the four-dimensional continuum and agreed with the observed facts of Nature, including the then untested bending and reddening of light. At first he had tried to amend Newton's law to fit the continuum, but he soon found it was a case of amending the continuum so as to fit Newton's law. Or rather, since a perfect fit was impossible, this being the cause of all the trouble, he amended the continuum so as to fit Newton's law in the only region where it could fit, namely, at infinity, and then found that the misfit for nearer distances gave just the needed 43″ a century for Mercury's orbit. Just as completely as, some three centuries earlier, the kinematical explanation of cycles and epicycles had crumbled to nothing in the hands of Kepler and Newton, so now the dynamical explanation of a gravitational force crumbled in the hands of Einstein. The story of this part of Einstein's work has been so often told and is so familiar to all astronomers that you will scarcely wish to linger over it. It opened up a path into entirely new scientific territory along which Weyl and others have advanced, attempting, so far as can at present be seen with success, to extend Einstein's fundamental conceptions so as to explain the "forces" of electromagnetism in terms of a still further generalisation of the geometry of the continuum. If they have succeeded, the mechanism of the whole universe is transformed; dynamics disappears from science and the laws of Nature are those of geometry alone.

We need scarcely spend time over the threadbare and rather meaningless question of whether Einstein has performed the feat of "abolishing the ether." So much depends on what we mean by "ether." As soon as the term is defined, the question as to whether or not that particular ether exists almost answers itself—generally in the negative. The luminiferous ether of Kelvin, Maxwell, and Faraday, largely as the result of Einstein's new outlook on the universe, may be described as dead; it is no longer a serious scientific hypothesis, but merely an item in the unscientific jargon of popular expositions of "wireless."

Let us take a glimpse at the new universe into which Einstein's work has led us. Until the seventeenth century the majority of men believed that terrestrial life was the prime reason for the existence of the myriads of stars that lighted the firmament; they had indeed been created just a few days before man so as to be ready to minister to his pleasure on his arrival. In the twentieth century the majority of men believe that there is a sort of flow of time which is regulated by our consciousness. We live now in the year 1926, and therefore speak of 1925 as dead and past; 1927 is not yet born, but will spring into life for us just as soon as we need it, which will be when we reach the end of 1926. So the traveller journeying west through Devon might suppose that Somerset had fallen out of existence at the moment he left it, and that Cornwall was waiting only for his arrival to come into existence. Foolish, perhaps, when expressed in terms of space, and yet our everyday belief in respect of time.

Einstein's theory eliminates the supposed essential difference between space and time; what is one man's space is another man's time. Not only so, but what is the past in time for one man is the future for another man. According to the view thrust upon us by the theory of relativity, the space-time landscape does not spring into life in front of us and die behind us; it is unalterably there. Existence becomes a picture rather than a drama, and the year 1927 has the same sort of existence as the county of Cornwall. Probably no one would regard this as a final statement of the matter; it goes as far as the theory of relativity carries us, but the theory of relativity is concerned only with inanimate Nature; it takes no cognisance of life or consciousness. It is for us to go further if we can.

Does the theory, however, leave room for us to go further? Does it leave room for life and consciousness, and for the attributes, such as free-will, which we attach to them?

The materialistic philosophy of a generation ago used to insist that the picture which science then presented of the universe left no room for such things. That picture has no doubt been torn to shreds, but what about the new picture? Does this look with any more favour on our instinctive belief that we can guide our actions and make the universe in some small degree different by our presence? Or are we mere passive spectators, carried—in a train the speed of which we cannot regulate and the course of which we cannot alter by an inch—out of a Devon with which we can do nothing except gaze at it through a window, into a Cornwall which is already in existence and has been unalterably created by other hands than ours? To this last question the answer of the theory of relativity would seem to be in the affirmative, but relativity is not the whole of natural science; it is not even the whole of Einstein's work. His contributions to science fall into two columns which, unhappily, are parallel and show no signs of meeting. The first column contains his contributions to the theory of relativity, the red-letter years being 1905 and 1915; the second column contains his contributions to the theory of quanta, the red-letter years being 1905 and 1916. It is not yet altogether clear which of these columns will figure most prominently in the history of present-day science when this is finally written in its proper perspective. But it already seems possible that the second column of Einstein's work may contain the needed antidote to the determinism and automatism to which the first column, if it stood by itself, would seem to condemn us.

This room contains, let us say, a thousand atoms of uranium. The chances are that after five million years only 999 of these will be left, the other one having been transformed into an atom of lead, eight atoms of helium and about 10^{-27} grams of radiation or heat. One of the thousand atoms is fated to be transformed in this way, but what determines which particular atom it is to be? Are we tempted to conjecture that it will be that one that gets most knocked about in the interval, or that gets into the hottest places, or what not? If so, we are wrong; for if blows or heat could disintegrate the one atom they could also disintegrate the other 999, and yet every physicist is firmly convinced that no possible treatment can retard or expedite the disintegration of the uranium atoms in the least degree. Once every five million years fate knocks at the door of one atom and it breaks up. Why fate chooses this interval, why she selects one particular atom rather than its fellow, we simply do not know; we seem to be beyond the domain of what have heretofore been called natural laws.

Now let us think of a more familiar, although more complicated, phenomenon. The hot filament of an electric light bulb receives energy from a dynamo and discharges it as radiation. Inside that filament millions of atoms are jumping up and down between different energy levels, and Einstein has investigated what may be called the statistics of their jumping about. Most of the knocks now are just those of ordinary radiation. The temperature radiation of the filament knocks some atoms up and some down; double the stream of radiation and the atoms will be knocked up and down twice as frequently. But this is not the whole story; if it were, the emission of light from the filament would not be what exact experiment shows it to be. Einstein finds that to explain the observed stream of radiation from the filament, fate must be invoked here also. Some atoms are knocked down from the high energy level to the lower because the stream of radiation pushes them down, but others stumble down by processes analogous to those by which the uranium atom disintegrates. They stumble, if you like, of their own clumsiness, or, if you like, because fate beckons them down. Put it anyhow you like, and you will almost certainly be wrong; Einstein has shown that it happens, and beyond this we know nothing.

It is, however, clear that we may be in the presence of something here which is quite beyond the inflexible cause and effect of the older mechanics, and possibly equally beyond the precreated tangle of events of the theory of relativity. A single instance will perhaps suggest how far beyond. The lines of the hydrogen spectrum result from the falling down of the atoms of hydrogen from one energy level to another, and in the determination of the wave-lengths represented by these lines, the future of the atom enters as an equal partner with the past, although, as we have seen, the future of an individual atom can no longer be regarded as a consequence of its past in the sense in which an effect is the consequence of the cause. We are here in unfamiliar regions of thought where our minds get frozen and refuse to operate. But one thing at least seems possible. It seems as though the deadly inevitability of cause and effect has ended, and we are in the presence of new possibilities of freedom which as yet we do not understand. Einstein's work on relativity changed the universe from a drama into a picture. It seems possible, as Weyl first suggested, that his work on quanta may have provided the clue which is destined to change it back again into a drama—no longer a drama in which all the parts have been written and the gestures prearranged before the curtain went up, but a drama in which all the actors choose their actions as the play proceeds—in fact, not a staged drama, but life.

No doubt the great mass of the universe must always follow a predestined path; nothing but predetermined forces can bind the cluster of the Pleiades or loose the bands of Orion or guide the Bear with its train, but there is now, for the first time since Newton, room in the universe for something besides predestined forces. No doubt this is only a possibility, only a conjecture if you like. We do not understand quantum phenomena well enough to go beyond conjectures. Perhaps a hope is dawning that some quite recent investigations of an abstruse mathematical nature are going to provide an answer to the puzzle, but if so it seems probable that the answer will not be in terms of ordinary time and space, and so will come from outside the regions surveyed by the theory of relativity. In any event it seems that there must be room for much in the universe about which relativity knows nothing. Perhaps the two columns of Einstein's work, which never clash because they never meet, provide a true symbolical picture of the universe which he has done so much towards elucidating.

Obituary.

DR. W. BATESON, F.R.S.

BORN in 1861, William Bateson was educated at Rugby School and at St. John's College, Cambridge, of which college his father was Master. He obtained first-class honours in both parts of the Natural Sciences Tripos, and took his degree in 1882. It was at the time when the genius of Francis Balfour had given a great impulse to the study of comparative embryology, and it was natural that Bateson's first efforts in research should be along such lines. As a subject for investigation he chose Balanoglossus, the position of which in the phylogenetic scheme was then one of uncertainty. To obtain material he visited America in 1883, and again in 1884. His results, which appeared in a striking series of papers in the *Quarterly Journal of Microscopical Science*, definitely fixed the position of Balanoglossus, and are now incorporated into every text-book of zoology. In 1885 he was elected a fellow of his college.

Not the least important outcome of Bateson's visits to America was the meeting with W. K. Brooks, who undoubtedly influenced his thoughts towards the direction they were now to take. The age-old problem of the nature of species gripped and held him for the rest of his life. Though fully appreciative of the value of morphological inquiry, he came to distrust the phylogenetic-speculations that were based upon it, involving as they did the assumption of hypothetical variations to fit the case. He demanded reality, and set to work to search it out. Holding that the facts of variation must be the test of phylogenetic possibility, he started to collect records of such variations as actually exist. The literature was searched, museums were visited at home and abroad, collections were made in the field, and it was at this period that as Balfour Student of the University of Cambridge he made a journey to the western parts of Central Asia and Siberia. The immediate outcome was the "Materials for the Study of Variation" (1894), a book which marked an era in the development of biological thought.

At that time it was generally held by professed authorities that variation was of the nature of a continuous process, and that the discontinuity of species was brought about by the operation of natural selection on such material. Logically this amounted to a denial of the existence of species as recognised by the systematist. Bateson reaffirmed the reality of species, emphasising the discontinuity between them, and pointed out that such discontinuity was paralleled by discontinuity in variation. As to the existence of this phenomenon the collected evidence left no doubt, and it was reasonable to suppose that the observed discontinuity in species was based upon discontinuity in variation.

To the naturalist the book was at once a warning and a call—a warning that the quest upon which he was engaged might be based upon illusion: a call to the study of variation, which at that juncture seemed to offer the fairest hope of progress in connexion with the species problem. Looking back, it seems surprising that the forceful reasoning of this remarkable book should not have made immediate converts. Yet so it was, and though the cause lay partly in mental inertia and indifference, it lay partly also in the rise of the biometrical school of evolutionists. Basing their methods upon the conception of variation as a continuous process, it was not unnatural that they should show a lack of sympathy with the evidence for discontinuity and all that it implied. Controversy became keen, and Bateson was more than once called upon to defend the position he had taken up. The ability with which he conducted his case, and the freshness of his outlook, began to attract to him the allegiance of some of the younger men, who felt that a new force had entered into their studies.

Meanwhile Bateson had started on another line. Satisfied as to the existence of discontinuity in variation, he felt that the next step was to discover how such varieties behave on crossing. He carried out an elaborate series of breeding experiments in Lepidoptera, especially with the *bryoniæ* form of *Pieris napi*, and certain geographical races of *Pararge egeria*. The results were difficult to interpret and he came to the conclusion that, if headway was to be made, material must be chosen in which the problem was reduced to its simplest form. In collaboration with Miss E. R. Saunders, a series of experiments was begun with plants where a sharp discontinuous variation existed together with the normal form, and a year later experiments planned on similar lines were undertaken with poultry. The aims underlying this work, and the hopes entertained of it, are set out in an address to the Hybrid Conference held in London during July 1899. Noteworthy is the announcement that discontinuity in heredity had already been detected, as also is the stress laid upon the necessity of examining the outcome of a cross *statistically*, and of marshalling the offspring in respect of each differentiating character separately. It was precisely this method of analysis that led to Mendel's success, and even if his famous paper had remained unknown, it is likely that the world would not have had long to wait for that guiding principle which lifted the study of heredity into its place among the exact sciences. Be that as it may, the discovery of Mendel's work in 1900 found Bateson well prepared. He intuitively recognised its high quality, and at once seized upon the essential truth of the purity of the gametes in respect of definite characters. In the following year he communicated to the Evolution Committee of the Royal Society an illuminating report, summing up the evidence and indicating the bearing of Mendel's discovery upon cognate lines of work. It was a report that opened men's eyes to the greatness of the achievement, and it exerted a strong influence in inducing others to pursue such investigations.

In Great Britain, however, there was opposition from one quarter, and that an influential one. The biometricians had already given evidence of hostility to the idea of discontinuity in variations. Exponents and upholders of what was known as the law of ancestral heredity, they could not but realise that the acceptance of the doctrine of gametic purity must shatter the very foundations upon which they were striving to build. With the revelation of discontinuity in heredity, it was open to them either to throw over the law of ancestral heredity, or to combat the new doctrine in whatever way they could. The latter course was chosen, and in *Biometrika* for January 1902 appeared a paper by Weldon minimising the importance of Mendel's discovery, and stating that neglect of ancestry was a fundamental mistake vitiating all work based on Mendel's methods. A challenge of this sort coming from such a quarter could not be overlooked. A great cause was at stake, and some few months later appeared "Mendel's Principles of Heredity: a Defence," a book in which Bateson gave free scope to his great powers of analytical criticism and to his remarkable gifts for controversy. The issue was joined, and Mendel was at any rate assured of his hearing. Two years later came the great clash at the meeting of the British Association in Cambridge. Bateson, as president of the Section of Zoology, delivered a stirring address vindicating the methods of Mendelian research, and challenging the conceptions of the biometrical school. The heated debate which succeeded it was keenly followed by a crowded audience, and at the end of it there was no mistaking the feeling that the exponents of Mendel had made good.

Meanwhile, Bateson had thrown himself wholeheartedly into the exploration of the fresh field that had been opened up, and the next few years were fruitful in discovery. To this period belong the formulation of the presence and absence theory, the solution of the old problem of reversion on crossing, and the demonstration of the nature of sex-linked inheritance. Another discovery of the first importance was that of linkage of characters. Originally detected in the sweet pea, the phenomenon was first fully explored in this material, and eventually fitted into an orderly scheme. Its later development in the hands of the American school of geneticists, and its translation into terms of the chromosomes, are now part of the history of science.

Bateson stood, however, for more than discovery. The new spirit that he breathed into the work, and the freshness of his outlook, were an irresistible attraction to many younger workers who desired nothing better than to cast in their lot with his. He became the founder and inspirer of a Cambridge school, and in 1908 the University recognised his peculiar position by creating for him the chair of biology. In the following year appeared "Mendel's Principles of Heredity," a critical survey of the state of genetical knowledge. Nevertheless, immersed as he was in breeding work, the problem of species was always with him; and when he was invited to deliver the Silliman lectures in 1907 he elected to give, not an exposition of Mendelian heredity, but a fresh consideration to the problems of variation and of species. The lectures eventually took permanent form in the "Problems of Genetics" which appeared in 1913. Perhaps the most valuable part of the book is the illuminating discussion on variation in connexion with locality and climate, though at the time of its publication the chapters which attracted most attention were those dealing with adaptation and the effect of changed conditions on the organism. About that time there had appeared several plausible accounts of the induction of a variation through a change of conditions, and of its subsequent inheritance. The searching criticism to which Bateson subjected the evidence was of the greatest service in checking any easy acquiescence on the part of biologists and others less familiar with such branches of inquiry.

The Cambridge period came to an end in 1910 on the acceptance of the directorship of the newly founded John Innes Horticultural Institution at Merton. It was a great opportunity, and Bateson made magnificent use of it. When he went there was nothing; in a few years there grew up a splendidly equipped station, and, of far greater moment, an enthusiastic and devoted band of workers. Here, too, his position gave him better facilities for promoting that co-operation between the practical breeder and the man of science upon which he had so often insisted. He made the breeder feel that his problems were also the problems of science, and out of his sympathy begat trust. Of his own inquiries at this period, and of those directly inspired by him, the key-note was segregation, its nature and the time of its occurrence. To this impulse we owe the striking series of investigations on variegation, bud sports, and root-cuttings, and on the phenomenon of anisogeny, accounts of which appeared from time to time in the *Journal of Genetics*; and it is in the fitness of things that his matured judgment on these phenomena should have appeared in that journal only a few days before his death.

Such in brief outline was Bateson's record of scientific achievement. Fearless in criticism and generous in appreciation, he stood above all for that spirit of freedom in inquiry through which alone the world may progress to better things. In that noble passage which concludes the preface to his greatest book, he has recorded for us in unforgettable words his lofty conception of the calling of the naturalist. By no man has this been more finely set forth: by none has it been more truly lived.

PROF. J. F. GEMMILL, F.R.S.

JAMES FAIRLIE GEMMILL was born at Mauchline in Ayrshire, and went from the village school and Kilmarnock Academy to the University of Glasgow. After a long and distinguished course in arts (honours classics, 1890), medicine (M.D. honours, 1900), and science (D.Sc. 1910), a period in Germany, a taste of medical work, and some travel, he became a research fellow in embryology in the University of Glasgow and a teacher of zoology to training college students. He was greatly influenced by the anatomical teaching and evolutionary thinking of Prof. John Cleland, for whom he had a very strong affection.

It was early in the Glasgow period that Gemmill became keenly interested in the Millport Biological Station, to which for many years, with extraordinary persistence, he devoted much of his time, not only contributing to the output of research, but also encouraging others to join in, and otherwise helping in the educational side of the Station's work. Until he was called to the Dundee chair of Zoology in 1919, Gemmill was a disinterested and loyal friend of the Millport institution, which after many ups and downs of youth has at length attained to a vigorous maturity. Others have greatly aided, but Gemmill's patient fostering in early days should never be forgotten.

Gemmill had wide zoological interests—anatomical, faunistic, ecological, and embryological; but the last was strongest. His researches on the development of echinoderms will form his chief zoological monument; they are masterly in their precision of observation and shrewdness of judgment. But one remembers also his embryological studies among cœlenterates, and his big memoir on the teratology of fishes (1912). When he went to Dundee, he told us that he had passed a self-denying ordinance, and was going to devote himself for some years to a study of practically important farm-pests; and so he became immersed with his usual enthusiasm in the unravelling of the life-history of a species of Bibio, and of some other parasites, such as an elusive tapeworm that is common in lambs. He had a great interest in mechanical devices, of which his little marine aquarium was the simplest—a study aquarium in which he kept sea-animals flourishing in the heart of Glasgow, and even discovered new Clyde species from there. We hope his technical ingenuities will not be lost sight of.

Prof. Gemmill was very happy in his Dundee years. He enjoyed the concentration of his academic work and the opportunities it gave him for diffusing and fostering an interest in biology through the Natural History Society, and the like. His election to the Royal Society came as another encouragement. He found great delight in furnishing an interesting old house, and he was helped at every turn by his niece, to whom he was devoted. He was never the same after her sudden death in 1924.

We should like to be allowed to pay a more personal tribute of affection to one whom we have been proud to call friend for many a year. Gemmill was a singularly lovable man, quiet and gentle, but very strong in grip and firm in judgment. Even for Scotland he was unusually thoughtful, always pondering; even for a scientific investigator, he was unusually cautious. Thus his clear-cut judgments, when the evidence seemed to him sufficient to warrant a conclusion, were always worth waiting for. Of judgments on persons we never heard him give one, though he had his share of fighting, and when an outspoken personal condemnation was uttered in his hearing, his grave face would become graver still and sad. Yet he was no 'Heaven and Hell Amalgamation Man'; on the contrary, a very clear-headed discriminator of persons.

What a fine companion Gemmill was, radiating cheerfulness, enlivening on a long walk, heartening when the dredge was coming up, magnanimous on the golf course, but always in his own peculiarly restful quiet way. Never of the strongest, he was very wiry, with great power of physical endurance, and on his holiday in Norway last summer, with a great sorrow, not even dulled, as his shadow, he probably walked harder than was wise. Whether over-tired or specifically infected, he came home under a cloud of nervous depression which became darker and darker until at the last it overwhelmed him.

Gemmill was an upright man, reverent, good through and through; he was frugal and abstemious, fond of his kindred and friends, full of kindliness to all men of good-will. He liked simple pleasures—always keen on a walk; he loved children; he delighted in his garden, his study-aquarium in Glasgow days, the flowers of the field, his pets—the dog most of all. He enjoyed meeting people when the day's work was done and he had a talent—perhaps a genius—for friendship. That he was pre-eminently interested in zoology is obvious, and he once told us that he was glad that amid ups and downs he had been able to hold by an early resolve that he would allow nothing—even teaching—to come between him and investigation. Often we pressed him to write a book, for he had very individual ideas, about organic evolution, for example, combining Lamarck's outlook with Goethe's, but he always resisted what he smilingly called a "temptation." We must think of Gemmill as one who made a great success of life, for he had the joy of many red letter days of discovery along the line which he had proposed to himself as his. Amid all his profound seriousness he greatly enjoyed Nature and many of the pleasures of human life; and was he not greatly beloved?

Why was it that we all, so different from one another, liked the man so much? Perhaps part of the reason was our quick discovery that he was thinking more about us than about himself. It was not only that he was overflowing with kindness, but he had also the rare gift of affectionate interest—half a naturalist's, half an artist's—in individuality. He took pleasure in our eccentricities; he delighted in our ruggednesses; he enjoyed our upsetting enthusiasms. Alas, alas, that there was no staying the Fury with the abhorred shears; but we doubt not that our friend will live on for his full span in the minds of many made better by his presence. J. A. T.

WE regret to announce the following deaths:

Prof. A. C. Eycleshymer, Dean of the College of Medicine of the University of Illinois, distinguished for his work on vertebrate embryology, on December 30, aged fifty-eight years.

John K. Hillers, an early member of the United States Geological Survey who, while in charge of the Photographic Laboratory of the Survey, was responsible for many photographs of noteworthy geological features of the western United States which have passed into text-books and reports, on November 14, aged eighty-two years.

Dr. Martin Murphy, president in 1902–3 of the Canadian Society of Civil Engineers, distinguished for his work on railway bridge-building, on January 10, aged ninety-four years.

The Hon. Sir H. A. A. Nicholls, lately Principal Medical Officer of Dominica, West Indies, known for his work on tropical diseases and on tropical agriculture, aged seventy-four years.

Prof. H. Kamerlingh Onnes, For. Mem. R.S., for many years Director of the Physical Laboratory at the University of Leyden, and Nobel prizeman for physics in 1913, on February 21, aged seventy-two years.

M. Adrien Robert, of the Sorbonne, secretary of the Zoological Society of France, on November 16, aged fifty-eight years.

Dr. M. B. R. Swann, fellow of Caius College and demonstrator in pathology in the University of Cambridge, from blood poisoning contracted during a *post-mortem* examination, on February 16, aged thirty-two years.

Mr. J. Whytock, first president of the Botanical Society of Edinburgh and a recipient of the Victoria Medal of Honour of the Royal Horticultural Society, on February 1.

News and Views.

THE president and council of the Royal Society decided at their meeting on February 18 to recommend for election into the Society the following fifteen candidates: Dr. J. A. Arkwright, Dr. E. J. Butler, Lieut.-Col. S. R. Christophers, Prof. F. J. Cole, Mr. A. C. G. Egerton, Dr. Ezer Griffiths, Mr. H. B. Hartley, Dr. H. Hartridge, Prof. G. B. Jeffery, Prof. O. T. Jones, Prof. W. C. McCullagh Lewis, Prof. E. A. Milne, Mr. L. F. Richardson, Mr. H. T. Tizard, Prof. R. S. Troup.

THE following have been recommended for fellowship of the Royal Society of Edinburgh: Prof. K. W. Braid (Glasgow), Prof. A. E. Cameron (Saskatchewan), Mr. R. T. Francis (Purley), Mr. J. D. Gardner (Edinburgh), Prof. J. G. Harrower (Singapore), Lieut.-Col. W. F. Harvey (Kasauli), Dr. S. R. Khastgir (Edinburgh), Dr. N. S. R. Lorraine (Hull), Mr. J. A. M'Bride (Glasgow), Very Rev. Dr. D. MacKichan (Edinburgh), Dr. D. C. T. Meikie (Edinburgh), Mr. J. A. Morris (Ayr), Dr. D. Patton (Glasgow), Dr. B. Prashad (Calcutta), Mr. J. A. F. Roberts (Edinburgh), Mr. W. H. C. Romanis (London), Colonel Sir Bruce Gordon Seton (Edinburgh), Prof. J. Small (Belfast), Dr. W. N. Stokoe (Edinburgh), Prof. G. H. Thomson (Edinburgh), Dr. J. Thomson (Glasgow), Mr. C. P. G. Wakeley (London), Mr. S. Williams (Glasgow).

A FURTHER stage in the development of the comprehensive scheme of irrigation for Egypt and the Sudan, forming a corollary to the work recently carried out at the Sennar Dam and described in the issue of NATURE of February 6, is detailed in the report, just issued by the Public Works Department of Egypt, relating the results of the mission despatched in 1920 to Lake Tsana, in Abyssinia, for the purpose of considering the possibility of converting the lake into an artificial reservoir. Lake Tsana is the source of the Blue Nile, which is controlled on the Gezira Plain by the Sennar Dam. The verdict of the mission is that the lake is eminently suitable for the purpose in question. The annual discharge during normal years is estimated at 3500 million cubic metres, and this is the amount that could generally be stored. But by certain engineering operations, including excavation of the rock sill at the outlet, it would be possible to increase the reserve storage to 8000 million cubic metres, which would be sufficient to meet deficiencies, if two seasons of low supply were experienced in succession. This reserve storage of 8000 million cubic metres, added to the annual supply of 3500 million cubic metres, would therefore give the reservoir a total effective capacity of 11,500 million cubic metres. The report estimates the cost of the work at £E2,300,000, and it is indicated that the work could be completed without the necessity of establishing any permanent means of communication with the Sudan; but if a railway or road to Gedaref should be found necessary, an increase in expenditure would follow. The Abyssinian Government has regarded the matter favourably and given its co-operation in the investigations. It is hoped, therefore, in view of the fact that the waters of the lake are of no service to the inhabitants for irrigation of its shores, while they would undoubtedly be of considerable value to Egypt and the Sudan, that the Abyssinian Government will grant at an early date the desired facilities for constructing the proposed regulation works.

THE Department of the Interior, United States Geological Survey, has just published the statistical summary of petroleum production and consumption for the year 1923, from the compilation of Mr. G. B. Richardson. In this memorable year all previous records for the output of crude petroleum in the United States, and, incidentally, for the world, were broken by the production in that country alone of 732,407,000 barrels of oil, constituting 72 per cent. of the total world's output for that year. This figure also implies a 31 per cent. increase on the output of the United States for the previous year, and was attained largely as the result of flush production from a number of rich pools, the maximum yield of which occurred during this year. The domestic production of the country was further augmented by imports of crude oil amounting to 82,015,000 barrels, thus creating a record total supply of oil in America of 814,422,000 barrels. Consumption, on the other hand, was less than domestic production, for the first time since 1914.

THIS extraordinary output of petroleum in 1923 created a serious phase of over-production and brought with it a corresponding slump in prices of crude oil and a depressed state of the oil industry generally, from which recovery has been slow. Since 1923 a considerable body of opinion has been expressed that that year's production of petroleum represented the 'peak' of the United States, and probably of the world, and some rather gloomy forebodings regarding the future of petroleum supplies have been voiced, both in the United States and in Europe. For many reasons there may be expressed some doubt on this point, though it is not denied that once the peak is definitely passed, the life of petroleum supply may be a comparatively short one at the present rate of consumption. On the other hand, the advent of a new pool comparable with any one of those responsible for the flush production of 1923 would quite possibly bring an annual total up to that of that particular year; and as there is no reason to suppose that the last 'bonanza' oil-pool has been found, there is still some hope that 1923 was not the 'peak-year' of either United States production or of that of the world.

A REFRIGERATOR which is claimed to be the only known contrivance for the continuous production of cold without the use of mechanical moving parts was brought before a large gathering at the Savoy Hotel in London, on February 23. The machine is being put on the market as the Electrolux Refrigerator (153-155 Regent's Street, London, W.1). It operates on the Platen-Munters system, ammonia being used as the working fluid, and hydrogen is employed to keep the pressure uniform throughout the plant. A cylindrical iron vessel containing a solution of ammonia is heated, preferably electrically; the water vapour is condensed and runs back into the 'generator,' and the ammonia passes on, being condensed in a water-jacketted tube leading to the 'evaporator.' Here it descends over baffle plates and evaporates, producing a lowering of temperature of the 'evaporator' and non-freezing solution surrounding it, and so of the chamber which it is required to cool. Ammonia gas, with the hydrogen filling the plant, passes down the 'evaporator' to the 'absorber,' where it meets a weak solution of ammonia running under gravity from the 'generator.' The ammonia is absorbed and passes back to the 'generator' by an ingenious 'trap' actuated by the heating element, while the hydrogen released goes on again to the 'evaporator.' The whole apparatus is of iron and is sealed, and there are no mechanical parts to require attention. Small plants only were shown, but other models are being produced.

THE prevalence and danger of insect pests in connexion with the growing of cotton led the Department of Agriculture in the Tanganyika Territory in 1922 to establish rules concerning the cotton crop. Two of the rules provide for the uprooting and destruction of all cotton refuse remaining at the end of the cotton growing season. A leaflet entitled "What to do at the end of the cotton season and why?" has been issued recently to planters and native cultivators. The dangers and breeding habits of insect pests, such as the red cotton-stainer and pink boll-worm, are pointed out, and reasons are given for the rules prescribing the uprooting of cotton and the destruction of wild plants allied to cotton at the close of the season. 'Ratoon' cotton in Tanganyika tends to harbour such insect pests and provides a ready source of infection for the new crop in the succeeding season, for such 'ratoon' plants produce bolls much earlier than the plants of the new crop. Similarly, dead stalks and other refuse from the cotton crop, if not destroyed, harbour the pests during the period between crops. Weeds such as Hibiscus and trees like Bombax (Eriodendron) may also enable the pests to carry over from season to season. The leaflet thus advocates thorough cleaning up of all plantations, as early as possible, pointing out that the earlier the clean-up the longer will be the famine period for the insects. The leaflet is printed in English and in the native language.

SEASONAL forecasting in India has been developed for some years, and considerable progress has been made in the application of statistical methods to weather prediction. A memorandum on the probable character of the weather in north-west India in January, February, and March was issued last month by Mr. J. H. Field, Director-General of Indian Observatories. Out of four principal factors available, two are practically neutral; these are the December rains at Port Blair and the pressure at Seychelles in November and December. The December rains in the western region were adverse, while the factor of rainfall at Seychelles in November and December and at Zanzibar in December was favourable. The seasonal change of the upper-air currents in northern India at a height of 3 to 5 miles above sea-level promises to prove of importance as observations accumulate; the prospect of winter rains from November to March for north-west India bears a close relation with the relative vigour of these high-level winds during the latter half of September and in October. The factor of the upper winds indicates a slight excess of precipitation. The final conclusion from all data available is that the winter precipitation, rain and snow, in north-west India is likely to be normal.

UNDER the title of "The Botanical Case for Evolution," the veteran palæobotanist, Dr. D. H. Scott, writes entertainingly and instructively in the *Nineteenth Century* for February. Pointing out that the experience of plant-breeding, whether carried out by the cultivator or the experimenter, shows that species are often not unchangeable, he bases the case for evolutionary change in Nature upon the following grounds: (1) Classification and its recognition of affinity, most readily interpreted in terms of descent; (2) the fundamental unity of organisation throughout the living world; (3) the comparison of organs and structures in different groups of plants, which show us an organ functional in some species, useless in others, turned to fresh uses in yet other species, etc.; (4) the geological record, in spite of such 'abominable mysteries' as the sudden appearance of the flowering plants in the Cretacean period. In his concluding remarks Dr. Scott quotes with evident sympathy from Witham of Lartington, the first to investigate the structure of fossils, who wrote in 1833: "To lend my aid in bringing from their obscure repositories the ancient records of a former state of things with the view of disclosing the early and mysterious operations of the Great Author of all created things will ever be to me a source of unalloyed pleasure." There can be little doubt that for Dr. Scott, too, it has been an unalloyed pleasure to attempt to disclose the "early and mysterious operations" in the history of the vegetable kingdom, and the result has been the great series of monographs, and still more the 'Studies' through which most of the present younger generation of botanists first make their acquaintance with the flora of the past.

THE anthropometric measurements made in the schools of England and Wales as a part of medical inspection are intended primarily as a test of physique and, except in a limited degree for specific purposes, or experimentally, their correlation with mental characters has not been attempted. The difficulty of any extended investigation of mental characters lies in securing uniformity in standard when anything involving a process which is not susceptible of a straightforward mechanical record is attempted. This difficulty vitiates to a certain extent some interesting investigations made by Dr. Arthur MacDonald of Washington, D.C., in which he has attempted to correlate mentality with physical measurements. A summary of his results was given in the *Medical Times* for November. According to his figures, dolichocephaly both as an individual and as a racial character appears to be associated with dulness and unruliness; brachycephaly with brightness; further, that both dolichocephaly and dulness increase after puberty, while brachycephaly decreases. He also records some interesting and rather surprising results relating to the correlation of physique and individual history of disease in students. Dr. MacDonald's figures must be taken for what they are worth, and although based upon a large number of observations, his inferences should be accepted with reserve. He attributes to anthropologists some sweeping conclusions on head form which few would endorse without qualification. It is scarcely necessary to point out the value to educationists of research which would show a valid correlation between physique and mentality to be generally applicable, even on the broadest lines, and not confined to abnormalities.

THE latest annual report of the Bristol Museum and Art Gallery records the offer of Sir George A. Wills to provide an extension of the building on the recently acquired site of the old Drill Hall, at a cost not exceeding 75,000*l*. The offer, which was accepted "with intense gratification," provides for a new Art Gallery to the plans of Messrs. Frank W. Wills and Sons, the architects of the existing gallery. This will occupy a little more than one-third of the whole site; the present gallery will be devoted to ethnography and antiquities, again about one-third; while the remaining third will be entirely available for the natural history collections, except for the large lecture-theatre serving the whole. Important bequests recorded comprise a collection of foreign lepidoptera, formed by the late Mr. G. C. Griffiths; a collection of big-game heads and native weapons, from the late Sir William Garstin; and a collection of British and foreign birds and 120 Baxter and Le Blond prints, from the late Mrs. Dalton-Burgess. The fine collection of engravings formed by Mr. Heber Mardon and presented by deed of gift in 1919 together with his extra-illustrated copy of Nicholls and Taylor's "Bristol Past and Present," in fourteen large volumes, was handed over by the family on Mr. Mardon's death in 1925. All this has thrown much work on the staff, and it is the more satisfactory to note that the valuable geological collections of the Museum are being made more accessible than they have been for many years, and that important specimens have been brought to light. Alderman Eberle and Dr. Herbert Bolton are to be congratulated on a report that shows progress in every direction.

THE British Museum (Natural History) is issuing a remarkable series of picture postcards illustrating many of the most interesting specimens contained in the Museum collections. A particularly attractive set of these cards, lately published, includes selected representations of exotic butterflies, moths, beetles, homoptera, heteroptera, and orthoptera. The figures are admirably executed in colour, and each packet of five cards (price 1*s*.) is furnished with an explanatory leaflet giving a concise account in general terms of the group or subject illustrated, and directing especial attention to any points of interest shown by the specimens represented. Thus, the letterpress contained in one of the packets devoted to butterflies gives a general account of the curious phenomenon of seasonal variation in these insects, and then proceeds to a brief but accurate description and discussion of the examples represented on the accompanying cards. These comprise figures, beautifully executed, of three striking African forms, in two at least of which, *Teracolus achine* (a "white" butterfly, or Piernie) and *Precis octavia* (a nymphaline allied to our Peacock and Red Admiral), the differences between the seasonal phases are so great that they were long held to be distinct species. Another packet contains excellent figures of some of the splendidly coloured Swallowtails of South America, and directs attention, in its accompanying notes, to the mimicry of other South American butterflies adopted by some members of the group. The brilliant colours exhibited by several of the grasshoppers, beetles, bugs, and moths represented in other packets will be a revelation to many whose acquaintance with these groups is only slight. These features are well brought out by the method of representation employed, and the claim of the Museum, that as much care has been taken with the figures as if they were destined to illustrate scientific monographs, is completely justified.

WE are informed that the Museum of Practical Geology, 28 Jermyn Street, S.W.1, is closed for repairs until further notice. Access to the Library and Offices of H.M. Geological Survey may be obtained through the entrance in Piccadilly.

PROF. KARL VON DEN STEINEN, Berlin, world known by his anthropological explorations in Central Brazil, and Baron Erland Nordenskiöld, of the Göteborg Museum, have been elected honorary members of the Paris Société des Américanistes.

DR. F. A. BATHER, keeper of the department of geology, British Museum (Natural History), has been elected a foreign member of Die Kaiserliche Deutsche Akademie der Naturforscher zu Halle. This is the oldest scientific academy in the world, having been founded in 1652.

WE learn from *Science* that a physico-chemical institute, to serve as central laboratories for scientific work in Spain, is assured by a gift of 40,000*l*. from the Rockefeller Foundation. The site of the building will be provided by the Spanish Government. It will probably be near the Museum of Natural Sciences in Madrid.

PROF. A. S. EDDINGTON will deliver the Bakerian Lecture of the Royal Society on May 6, taking as his subject "Diffuse Matter in Inter-stellar Space." The Croonian Lecture will be delivered by Prof. A. V. Hill on the "Laws of Muscular Motion" on May 20. On March 4, a discussion on "The Electrical State of the Upper Atmosphere" will be opened by Sir Ernest Rutherford

THE Botanical Society of America, at its recent meeting in Kansas City, Missouri, elected the following corresponding members: Profs. A. Engler and K. Correns, of the University of Berlin; Prof. C. Sauvageau, of the University of Bordeaux; S. Nawaschin and Prof. R. Willstätter, of the University of Munich Previously elected corresponding members are Profs. V. H. Blackman, F. C. Bower, Hugo De Vries, K. von Goebel, and A. C. Seward.

A MEETING will be held at the rooms of the Linnean Society on Wednesday, March 10, at 3.30 P.M., to consider a suggestion that the fifth International Botanical Congress should be held in London in 1930, and, in the event of the suggestion being adopted, to formulate an invitation to be submitted to the ensuing fourth International Botanical Congress at Ithaca, U.S.A., in August next. The Hooker Lecture of the Linnean Society will be delivered this year by Prof. Carl Schröter, foreign member of the Society, of Zurich, on April 15, and will be entitled "The Swiss National Park and Scientific Researches into its Nature."

THE Empire Council of Mining and Metallurgical Institutions, Cleveland House, 225 City Road, London, E.C.1, on behalf of ten constituent bodies, has accepted the invitation of the Canadian Institute of Mining and Metallurgy to hold the second Empire Mining and Metallurgical Congress in Canada in August-September 1927. It will be recalled that the first Congress, from which the Empire Council arose, was held at the British Empire Exhibition, Wembley, in 1924, under the presidency of the late Viscount Long of Wraxall.

THE Royal Academy of Sciences in Sweden has appointed a committee, consisting of Prof. Osten Bergstrand, of Upsala, Prof. C. V. L. Charlier, of Lund, and Profs. Karl Bohlin and V. Carlheim-Gyllensköld, of Stockholm, to organise the celebration of the 350th anniversary of the foundation of Tycho Brahe's "Uraniborg"—the city of the heavens. This magnificent observatory, famous in the history of astronomy, was built in 1576 on the island of Huen, which was granted to Tycho Brahe for life by Frederick II., King of Denmark. The island now belongs to Sweden.

IN the House of Commons on Thursday, February 18, Mr. MacDonald presented a petition at the request of his co-Trustees of the British Museum. The petition recited the capital holdings which the Trustees had and the income derived from the holdings, and stated that the income was not sufficient to enable the Trustees to carry out their trust efficiently. In conclusion, the Trustees asked for "further support towards enabling them to carry on the execution of the trust reposed in them by Parliament for the general benefit of learning and useful knowledge."

ON the initiative of the Orientalists' Association of Leningrad, it is proposed to hold the first International Exhibition of Buddhism at Leningrad in the autumn of 1926. The nucleus of the exhibition will be furnished by the rich Buddhist collections of the Russian Museum of the Orientalist Association and of the Asiatic Museum of the Academy of Sciences. Japan, China, Tibet, Mongolia, and other countries will be represented. The Academy of Sciences has despatched Prof. Stcherbatsky to Japan and Prof. Alexeiev to China to collect exhibits.

IT is announced that further collections of objects discovered by Col. Kozlov in Mongolian mounds have been received at Leningrad. These include both Greek objects and objects of local manufacture showing Greek influence. Among the more remarkable are Greek fabrics and embroideries with designs of flowers, birds, and human figures in the Greek style. Particularly noteworthy is a piece of embroidery showing a group of horsemen. The Greek ornament and the Scythian dress, headgear, and harness of the horsemen suggest that the embroidery is derived from one of the Græco-Scythian settlements of South Russia.

THE Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation was established in the first place for the encouragement of medical and allied research, grants being made for the purchase of special apparatus and supplies and preference being given to researches on a single problem. According to the second annual report recently issued, thirteen grants varying from 40*l.* to 340*l.* were made last year, four of which were for investigations on chronic nephritis. Five of last year's grants were to workers in Europe. Applications for grants for the year 1926–27 should reach the secretary of the committee of the Foundation at Boston City Hospital, Boston, Massachusetts, before May 15.

Two awards are announced in the January issue of the *Journal of the Franklin Institute*; the John Price Wetherill Medal to Mr. F. Twyman, London, and the Edward Longstreth Medal to Mr. T. Midgley, Dayton, Ohio. The award to Mr. Twyman is for the Hilger interferometer, which provides a simple and accurate method of locating and correcting imperfections in prisms and lenses. It will be recalled (NATURE, July 14, 1921, p. 635) that in this instrument a beam of monochromatic light is divided into two parts, one of which is passed twice through the object under test. The two beams are recombined so as to produce a set of interference bands which form a "contour map" of the imperfections of the optical element under test. The award to Mr. Midgley is for the Midgley optical indicator. This instrument is a high-speed indicator for use with internal combustion engines. A beam of light falls upon a mirror the position of which is determined by the position of the piston in the cylinder. The light is reflected to a revolving mirror the position of which depends on the second element required, and a pressure-volume or pressure-time curve can be obtained. Novel methods of reducing inaccuracies due to inertia of moving parts are adopted and the use of a spring and piston in the pressure element makes it possible to use a uniform scale for the entire height of the pressure card.

THE provisional programme of the Optical Convention, 1926, which has now been issued, shows that every effort is being made to ensure that the Convention will provide a comprehensive and complete survey of British contributions to optics in recent years, and of the position of optical science and the optical industry at the present time. The Convention will be held, under the presidency of the Astronomer Royal, at the Imperial College of Science, South Kensington, on April 12-17 inclusive. Scientific and technical papers, dealing with every branch of theoretical and applied optics, will be read and discussed, and special discourses will be given, including lectures of a popular character accompanied by demonstrations. The most modern types of optical instruments and apparatus will be exhibited by British manufacturing firms in all branches of the optical trade. There are also to be exhibits illustrating the results of recent optical research and the application of optical methods in the laboratory. Demonstrations and dramatic performances, incorporating various interesting optical illusions and projection effects, are being specially composed for presentation during the Convention. Particulars of membership of the Convention and forms of application may be obtained from the Secretary, 1 Lowther Gardens, Exhibition Road, S.W.7.

THE technical programme has now been issued of the sectional meeting organised by the Swiss National Committee of the World Power Conference to be held at Bâle on August 31–September 12 next. The work of the meeting will be divided into five sections dealing with the utilisation of water power and inland navigation, exchange of electrical energy between countries, hydraulic and thermal production of electrical energy, electricity in agriculture, and railway electrification respectively. Contributions will be regarded as National Papers (presented on the initiative of a national committee or of a member of the International Executive Committee) or Reporters' Papers (prepared by general reporters appointed by the Swiss National Committee, summarising national papers presented before April 1 and emphasising definite aspects of the subjects discussed). Papers and discussions are to be published in a volume of proceedings. Communications for the British National Committee should be addressed to the Secretary, World Power Conference, 36 Kingsway, London, W.C.2.

H.M. STATIONERY OFFICE announces for publication at the end of the month a special edition of the "Nautical Almanac 1928" bound in cloth boards; the edition in wrappers is also available. The edition in cloth will be continued in future years if it is found to meet a public need. Both editions may be obtained from Mr. J. D. Potter, 145 Minories, E.1.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in pharmaceutical and general chemistry at the School of Pharmacy of the Pharmaceutical Society of Great Britain—The Secretary of the Society, 16 Bloomsbury Square, W.C.1 (April 12). A professor of zoology in the University of Calcutta — The Registrar, University of Calcutta, Senate House, Calcutta (April 12). An assistant lecturer in mathematics in the University of Leeds—The Registrar (April 21). A principal for the proposed University College for Hull—The Secretary to the Board of the College, Guildhall, Hull (May 1). Lecturers in historical geography and physical geography at University College, Reading—The Registrar. An honours graduate in physics as assistant under the British Research Association for the Woollen and Worsted Industries —The Secretary, Torridon, Headingley, Leeds.

Our Astronomical Column.

RECENT SUNSPOTS.—In our issue of February 20, p. 282, mention was made of the third appearance of a spot in south latitude 21°. When more fully on the sun's disc, it could be seen with the naked eye, and should therefore be included in the list of naked-eye spots, as follows:

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Area.
4	Feb. 13–25	Feb. 19·1	21° S.	1/2000

The spot was typical of a regular spot with well-defined filamentary structure of the penumbra and stable outline. It may be expected to return at least once again, though probably as a telescopic object only.

As noted last week, the great spot of January returned, but it was only about one-sixth of its previous size. It was accompanied, however, by a very extensive region of bright faculæ, seen easily when near the sun's limbs with a small telescope.

Spot No. 3, which was on the sun's central meridian on February 15, decreased rapidly and was of less than naked-eye visibility by February 16.

THE TEMPERATURES OF THE PLANETS.—The issue of the *Physikalische Zeitschrift* for December 23, 1925, contains a report by Dr. E. Schoenberg on the present state of our knowledge of the temperatures of the planets. For planets still in the gaseous state there is as yet no satisfactory theory connecting the radiation sent out with the temperature distribution, but for those having solid crusts, either with or without atmospheres, Milankowitsch in his recent book has provided a satisfactory theory, which the author reproduces in the earlier sections of his report. He then describes the radiometer measurements made during the past twelve years at the Lick and Arizona observatories, and gives as the most reliable values of the surface temperatures: Venus 45° C., Mars −15° C., Jupiter and Saturn −80° C., the value for Venus being somewhat doubtful, but the others much more trustworthy. Dr. Schoenberg concludes his report by describing a method he has devised, and already applied to the visible portion of the spectrum, for determining the density and temperature of the atmosphere of a planet at any depth below the visible surface, by photometric measurements of the twilight band at the terminator, his theory being that the brightness of this band is due to diffusion only, and not to absorption.

Research Items.

Megalithic Works in Fiji.—In *Man* for February, Mr. James Hornell figures and describes some of the megalithic sea works and temple platforms at Mbau in Fiji. Mbau is the most historic place in Fiji and was the seat of government of Chief Thakombau, who in the middle of the last century brought many of the other chiefs under subjection. The sea works which are described consist of a number of docks and piers into which the big outriggers and double canoes were run. Of these docks there are now twenty-five, some of which were made during the latter part of the last century by dividing up the larger docks. The sides of the wharves are protected in three different ways, of which the most characteristic is by means of large slabs of rock set on edge, of various sizes running up to 11 feet 8 inches in height. Little attempt has been made to shape them. The most important of these docks was probably the ceremonial landing-place of the head of the dominant community. Prisoners of war were possibly also landed here and brained for the ceremonial feast. As regards the age of these structures, a comparison with a similar structure at Mua (Tongatabu), which may be connected with the sons of the Tongan king Tui-ta-tui, suggests the end of the thirteenth century as a possible date.

Psychical Methods in Medicine.—In *Psyche* (January 1926) Dr. F. G. Crookshank contributes an interesting article entitled " Spiritual Healing in the Light of Modern Medicine." He directs attention to the lamentably slack use of terms implied in such phrases as organic versus functional disease, suggestion and faith healing, physical versus psychical methods of cure, which phrases, he thinks, have long outlived their usefulness. He pleads for a stabilisation of verbal symbolism on a basis of real values. Although physicians profess to have no metaphysical prejudices, much of their actual practice is based, not on any assured basis of observation, but on the dregs of the psycho-physical parallelism of the last century. The result has been a neglect of the functional neuroses by the orthodox physicians. The antinomy between functional and organic disease was invented in order that " we might say that organic disease is what we say we cure but don't, while functional disease is what the quacks cure and we wish to goodness we could " ! Actually, the so-called physical and the so-called psychical methods are indistinguishable objectively, and the prescriber of drugs is often aware that faith plays no small part in procuring the efficacy of the drug. He believes that the scope of psycho-therapy is coterminous with the whole range of disease, though never to the exclusion of what we call physical methods Wherever there is scope for psycho-therapy there is a mental conflict, and this is present far more frequently than is imagined in cases deemed to be suffering from organic disease only. But it is necessary to adopt a changed attitude in respect of the mind and matter controversy. Dr. Crookshank protests against the assumption that the rational foundations of science are all well laid, and he maintains it is unscientific to reject testimony of strange occurrences just because such are thought incompatible with what we call science. The article is thoughtful and provocative, and is worthy of consideration by all those whose work involves dealing with people, whether in the capacity of physician, teacher, preacher, or employer. It is well at times to revise one's assumptions.

Action of X-Rays on the Developing Chick Embryo.—Drs. Colwell, Gladstone, and Wakeley (*Jour. Anat.* 60, pp. 207-28, January 1926) give an account of a series of experiments designed to test the effect of X-rays on the developing embryos of the fowl. In an earlier paper the authors concluded that, in embryos irradiated immediately before incubation and then daily for several days, the action was always inhibitory, the irradiated embryos being invariably smaller than the controls Those which received the full pastille dose of X-rays were most affected, six out of nine showing no development at all. In all those showing development, all tissues and organs which should normally be developed were differentiated but smaller in size. The effect was therefore one of retardation or diminution of growth. In the present paper the authors give the results of experiments in which the embryos were allowed to develop normally for four days and then subjected, in two groups, to daily irradiation of three and five days respectively. In these cases there did not seem to be any marked effect on the average length of the embryos compared with controls. The principal action of the rays appeared to be their destructive effect on the tissues, exerted chiefly on the cutaneous ectoderm, the neural tube and its associated structures, the epithelium of glandular structures such as liver and mesonephros, and on the red blood corpuscles. The effects showed themselves in detachment of the epithelium, in a diminution in the transparency of the cytoplasm, and in the formation of granules or vacuoles in the latter.

Citrus Fruit in the Philippines.—According to A. H. Wells, F. Agcaoili, and Maria Y. Orosa of the Bureau of Science, Manila, there are about eight hundred types of citrus growing in the Philippines, including the valid indigenous species, the hybrids, and the introduced species. At the same time there is not a single citrus plantation on modern commercial lines in the islands, whilst, on the other hand, the Filipinos seem to appreciate the fruit as the returns of the importation of citrus into the islands demonstrate. The Lamao Experiment Station has now shown that quite good produce can be obtained upon trees of commercially valuable types when grown under Philippine conditions, and the authors urge that citriculture should be taken up by the inhabitants upon a commercial scale. Their paper in the *Philippine Journal of Science* (vol. 28, No. 4, December 1925) contains particulars of the very complete selection of types of citrus under experimental cultivation in the Philippines, and also of chemical analyses of the fruits of selected varieties.

Contributions to Plant Physiology.—The numerous investigations recorded in Year Book No. 24, issued by the Carnegie Institution of Washington, include reference to the continuation at the laboratory of plant physiology at Tucson, Arizona, of work on desert succulents. V. Úlehla shows, by auxograph records of the swelling of succulent tissues in solutions of different concentration, that the methods developed by Ursprung and Blum for determining suction pressure, require supplementing by further experimental methods before valid conclusions as to suction pressure values can be drawn with safety. The work also emphasises once more the very complicated nature of the phenomenon of plasmolysis. H. A. Spoehr and Paul C. Wilbur show that in the presence of disodium phosphate and sodium pyrophosphate the aldose sugars are converted into the ketoses, and vice versa A noteworthy feature of this form of the von Eckenstein reaction is the disappearance of reducing power with time; this suggests that the reaction is not a true equilibrium but that the hexose molecule itself is being split. An interesting contribution to our knowledge of the absorption of carbon dioxide by leaf-powder is made by H. A. Spoehr and William Newton. From an ether water extract of the leaf-powder an equal volume of 95 per cent. alcohol throws down a precipitate of a substance which absorbs considerable quantities of carbon dioxide, and of which some of the reactions are given.

British Post-Pliocene Unionidæ.—Owing to the fragile nature of their shells, the Unionidæ found fossil in the Pleistocene deposits are commonly fragmentary and the discrimination of the species is difficult. A. S. Kennard, A. E. Salisbury, and B. B. Woodward (*Proc. Malacol. Soc.* 16, 1925, p. 267) give an account, illustrated by twelve photographic plates, of the British species, which will be of value to workers in Pleistocene geology. The external form of the shell, owing to its variability, is of little use in distinguishing species. The features of specific value are seen in the muscle scars, the hinge, and the umbonal rugæ.

Ammonites from the Upper Kimmeridge Clay.—A pleasing quarto-publication by Dr. E. Neaverson on the Ammonites from the Upper Kimmeridge Clay has been issued as one of the Papers from the Geological Department of the University of Liverpool. The memoir deals mainly with the small group of the so-called *Ammonites biplex* (more recently referred to as *Olcostephanus pallasianus* auct.) of the Upper Kimmeridge Clay. They are now described in detail and with care for the first time, and they are referred to a number of genera and species; but Dr. Neaverson remarks that the large majority of specimens are flattened by pressure and form "hopeless" material for investigation. The characters relied on by the author for subdivision are the general form of the suture-line and the developmental stages shown by the ammonites. Unfortunately, the author has not been able to dissect any species of, for example, his first genus (Virgatosphinctoides), and he figures only one complete suture-line, belonging to an undetermined species of doubtful generic affinity. The genus Virgatosphinctoides, we are told, includes Mr Pringle's Pseudovirgatites from the Oil Shales of Kimmeridge; and Dr. Neaverson, whilst expressing the "belief" that the phenomenon of homœomorphy is responsible for the similarity between the two groups, leaves the determination of possible relationship to future research. There is no indication that the author has studied the Volgian Virgatitids of Russia any more than the Mediterranean genera, except in published figures; and recent literature is not sufficiently noticed. The arrangement of the various ammonites into separate lineages thus reflects a somewhat limited outlook. The work, however, was obviously done conscientiously, and the four plates are good.

Grass Minimum Thermometers.—The Meteorological Office, Air Ministry, in Professional Notes, No. 43 (London: H.M. Stationery Office, 1925, price 6*d.* net), publishes "Some Effects produced by Protective Shields on the Readings of Grass Minimum Thermometers," by Mr. J. M. Stagg. At cold periods in such winters as the present, the thermometer exposed at night to radiation over grass gives some low readings of interest, at times 10° F. or even more below the reading of the ordinary air temperature in the Stevenson screen close by. The position of the grass minimum thermometer screened by a wire cage is well shown by illustrations, and observations are made of the thermometer screened and of a similar thermometer outside the cage, but unscreened, near by. The results are obtained from five series of experiments conducted at Kew Observatory, which is ample guarantee of correctness, and the observations are carefully collated. The paper sums up with final recommendations for observers. It is asserted that any form of screen in the vicinity of a grass minimum thermometer will result in an increase of the temperature recorded, and it deprecates a screen even situated entirely on one side of the grass thermometer. To those accustomed to obtaining radiation temperatures, it is well understood that lower temperatures and a greater difference between the Stevenson screen thermometer and the radiation temperature is obtained by placing the radiation thermometer, filled with clear white spirit, on short grass, with the bulb just touching the tops of the blades of grass, but on no account embedded in the grass. The stem of the thermometer should rest on a small fork of wood to raise the bulb.

The Compton Effect.—The issue of the *Journal de Physique* for December 1925 contains a summary of the spectrographic observations of M. de Broglie and A. Dauvillier on this effect during the last two years. Compton discovered in 1923 that when homogeneous X-radiation is scattered by a solid, the scattered radiation contains, in addition to rays of the same wave-length as those incident, rays of longer wave-length; he explained this effect as due to the impact of a quantum of the incident radiation on an electron, which recoils carrying with it some of the energy, and the decreased energy of the scattered quantum manifests itself in an increase of the wave-length of the radiation it emits. Duane and his colleagues failed to verify Compton's observations, but the researches of de Broglie and Dauvillier on the scattering of the *K*-radiations of tungsten, silver, tin, copper, and zinc by graphite, boron, glucinium, and aluminium confirm the original observations and are in agreement with the theory by which Compton explained them.

Separation of Platinum Group Metals.—A new method of separation of iridium, rhodium and platinum, one of the most difficult tasks in chemical analysis, is published in the *Scientific Papers of the Institute of Physical and Chemical Research, Tokyo.* Titanous sulphate solution precipitates rhodium and platinum, while iridium remains in solution with the titanium. The iridium is precipitated by reduction of the acid solution with hydrogen sulphide in the presence of a suitable amount of glycerol. The platinum and rhodium mixture is treated with aqua regia, the undissolved rhodium filtered off, the solution reprecipitated using an aluminium plate, and the precipitate fused with potassium hydrogen sulphate, which on treatment with water leaves the platinum in an insoluble form.

Mixed Crystals of Silver Halides.—The results of X-ray analysis of mixed crystals of silver chloride and bromide and silver bromide and iodide by R. B. Wilsey have been published in the *Journal of the Franklin Institute* for December 1925. The powder crystal method of Hull was employed and showed that the chloride-bromide mixtures have the simple cubic structure, while most bromide-iodide mixtures contain two mixed crystals, one the bromide with enlarged lattice spacing, and the other the iodide with a slightly smaller lattice constant. The enlargement of the bromide lattice predicted by Trivelli seems to be connected with the increased speed obtained with photographic emulsions of silver bromide with small amounts of silver iodide.

The Report of the Medical Research Council.[1]

A FIRST perusal of the report of the Medical Research Council for 1924–1925 shows its many-sided activities: there appears to be scarcely a branch of medical science in which investigations have not been carried on by members of the Council's staff or by other research workers receiving whole- or part-time grants. The great volume of work performed is due in great measure to the utilisation of facilities provided by the universities and other institutions, by means of grants-in-aid to the investigators working therein. Research work, therefore, throughout the country is co-ordinated through the medium of the Council; and as specific problems arise, plans for their investigation can be formulated and the work entrusted to those most qualified to deal with it. In addition, grants have been made for work within the programmes of the Department of Scientific and Industrial Research, the Miners' Welfare Fund, the Dental Board of the United Kingdom, the League of Nations, the *Field* Newspaper Distemper Research Council, and the British Empire Cancer Campaign. The Council also makes the annual awards of the Rockefeller Fellowships, tenable in America by scientific workers in the British Isles.

It must not, however, be supposed that any distinction is made between 'pure' and 'applied' research. Every advance in knowledge leads, sooner or later, to a practical application, even though the latter may not be at first apparent.

It is obvious that it is impossible to deal with all the many-sided activities of the Council in the space at our disposal; stress will be laid on certain outstanding pieces of work, more especially those which have not been recently considered in these columns.

An extremely important function of the Council is the regulation of biological standards: that is, standards for certain substances of unknown chemical constitution, or, if of known constitution, presenting difficulties in chemical estimation, or possibly showing a varying therapeutic potency, although apparently of the same composition. Two important steps have been taken during the year: the Therapeutic Substances Bill has received the Royal Assent, and the second International Conference on the standardisation of biological products was held at Geneva in September under the auspices of the Health Section of the League of Nations, when a gratifying measure of agreement was reached as to the standards for a number of products. The president of the Conference was Dr. H. H. Dale, to whom, to a large extent, the success achieved was due.

At present the only substances which are required to be biologically standardised in Great Britain are salvarsan and insulin; and this is only due to the fact that the patent rights are vested in a public department. The international conference agreed on standards for pituitary extracts, thyroid gland, digitalis and *Filix mas* and other anthelminthics; investigation is still proceeding with reference to standards for suprarenal preparations and adrenaline, ergot, and vitamin preparations. It may be anticipated that the compounds in the former group will shortly be scheduled under the Therapeutic Substances Act, so that preparations of or containing them will only be allowed to be marketed if they comply with the requisite standard. In this connexion it may be mentioned that Dr. Hartley has prepared a standard sample of diphtheria antitoxin; this is the only serum for which a standard and a method of assay have been accepted by international agreement at the present time.

The Standards Laboratory at Oxford, under Prof. Dreyer's direction, has supplied standard agglutinable cultures and standardised agglutinating sera made with certain of the enteric and dysenteric organisms; the quantities issued have been 195 litres of the former and nearly four litres of the latter. The National Collection of Type Cultures maintained at the Lister Institute under the direction of Dr Ledingham has been increased during the year, and more than 4000 type cultures have been distributed to research workers both at home and abroad.

Research work has been carried out in a number of specific subjects by numerous investigators. The oxygen chamber at Guy's Hospital has been in use again during the year, and great benefits are reported from this treatment in bronchitis and asthma. Dr. Edith Willock, working with Prof. Raper, has demonstrated the existence of an anoxæmic type of infantile atrophy, which is treated by means of oxygen-enriched air.

The physiology of hæmoglobin, the respiratory pigment of the blood, has been further investigated by workers under the direction of Prof. Barcroft Anson and Mirsky have shown that hæmochromogen—often called reduced alkaline hæmatin—is really a conjugated protein, consisting of a base, named 'hæm,' and globin, and have been successful in synthesising it. The base unites with many other nitrogenous substances besides globin, and gives a series of pigments, some of which are found in invertebrate animals. Dr. Keilin, investigating a respiratory catalyst called 'cytochrome,' has found it to be present in the cells of all ærobic organisms so far examined, including animals, higher plants, yeasts and bacteria; it appears to be formed of three hæmochromogen compounds and so to be closely related to the respiratory pigment hæmoglobin.

Prof. Shaw Dunn, working with Drs. Lovett, Dible and McSwiney, has investigated some aspects of acute experimental oxalate nephritis; it was found that water diuresis in this condition favourably influenced the urea retention, producing a copious elimination of the latter by the glomeruli. No diminution in the rate of blood-flow through the kidney was observed in this type of nephritis. Dr. Baker has described two cases of obstruction of the renal tubules caused by excretion of hæmoglobin following the intravascular hæmolysis of transfused blood. Experiments made later showed that hæmoglobin, excreted through the glomeruli in solution in an alkaline medium, is precipitated in the tubules, probably in the form of hæmatin, owing to the increase in acidity and salt concentration This intrarenal obstruction probably occurs also in blackwater fever The treatment suggested is the production of an alkaline diuresis. Prof. Maclean and Drs. Urquhart and Forest-Smith have been able to show that rabbits given an exclusively protein diet for long periods do not develop nephritis or, in fact, show any sign of renal impairment, provided they are also given small amounts of cabbage; previous results pointing to the opposite conclusion appear to have been due to a lack of vitamins or some other constituent of fresh food. Thus an excessively protein dietary does not appear to be harmful to the kidneys.

Prof. Korenchevsky and Miss M. Carr have been engaged in a research on the influence of the internal secretions of the sexual and prostate glands upon metabolism They conclude that the former contain hormones which increase the nitrogenous metabolism;

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[1] Committee of the Privy Council for Medical Research Report of the Medical Research Council for the Year 1924–25. Pp 164. (London: H M Stationery Office) 3s. 6d. net.

the variable effects observed after injections of emulsions of either testes or ovaries are due not only to the specific hormones, but also to the presence of non-specific substances such as insulin, and to the varying efficiency of all the other endocrine glands in aiding or opposing the action of the hormones injected. Drs. Gardiner Hill, Jones and Forest-Smith have engaged in a study of different types of obesity and their relationship to the various glands of internal secretion. They consider that certain patients who present similar appearances to the diabetic receiving large amounts of insulin may be suffering from an excessive production or release of insulin from the pancreas.

Dr. Fletcher, working at Kuala Lumpur, has found that quinidine is as effective as quinine in the treatment of malaria, that the two alkaloids do not act specifically on one type of the malarial parasite, and that there is no difference in their toxicity. The question of the effectiveness and toxicity of the different cinchona alkaloids and their proportions in different species of bark is of considerable economic importance

Drs. Henry, Lewis, Chalmers and Harries have been investigating the toxin of the *Streptococcus scarlatinæ*; a stable preparation was obtained by precipitation with alcohol. Intradermal inoculation into human beings enables those who are susceptible to be distinguished from those who are relatively resistant; most young children are in the former group, and most adults in the latter; but children who have had the disease are also resistant. An antitoxin has been prepared the clinical trials of which are at present in progress.

A short section is devoted to some of the main aspects of the work of the Industrial Fatigue Research Board. The direct practical applications of much of this work, carried out 'in the field,' need scarcely be emphasised. The scientific study of workers in the factories leads to the formulation of conclusions as to the most beneficial methods of carrying out the various types of work examined, which should lead both to greater comfort for the worker and also to an increased output. Thus Mr. Wyatt and Mr. Fraser have shown that the judicious introduction of rest pauses almost always has a good effect, the workers unconsciously responding by increased efforts, so that the output is greater in spite of the shorter time worked. Thus shorter hours with higher wages seem to be no remote possibility.

University and Educational Intelligence.

CAMBRIDGE.—The death, in tragic circumstances, of Dr. M. B. R. Swann, the senior demonstrator in the Department of Pathology, has been a serious blow to the University in general and the Department in particular. It is not yet a matter of common knowledge that during the last few years this particular school, under Prof. Dean's guidance, has been the centre of renewed activity. In the first place, pathology has been introduced as a subject in the second part of the Natural Sciences Tripos. Students who wish to obtain a more detailed knowledge of pathological problems and a closer insight into modern research than is entailed by the crowded medical curriculum can now receive well-organised instruction. In addition, they have a definite status and also the advantage of receiving some acknowledgment for their trouble; as a result, competent research workers are being trained. The new pathological and veterinary building will, when completed, afford suitable accommodation for more workers. The staff is very keen and not over-encumbered with elementary teaching, so there are good prospects of considerable progress.

LONDON.—A course of three free public lectures on "Hygiene" will be given (in English) by Dr Gustave Monod, at the Middlesex Hospital Medical School, on March 2, 3, and 4, at 5.30 o'clock, and one of four (also in English) on "The Evolution of the Nervous System," by Dr. C. F. Ariens Kappers, at University College, on March 9, 10, 11, and 12, at 5.30 o'clock.

MANCHESTER.—Dr. John Samuel Dunkerly, senior lecturer in zoology in the University of Glasgow, has been appointed Beyer professor of zoology and director of the zoological laboratory in succession to Prof. S. J. Hickson, who will retire in September next. Dr. Dunkerly, who was a student of Birkbeck College, London, graduated in 1908, and later studied under the late Prof. Minchin at the Lister Institute of Preventive Medicine. He became an assistant-lecturer at Birkbeck College, and in 1911 was appointed lecturer in zoology in the University of Glasgow. He was on military service from 1914 to 1918, and in 1920 was appointed senior lecturer in zoology at Glasgow, obtaining the degree of doctor of philosophy there. A number of Dr. Dunkerly's papers have been published in the *Transactions of the Royal Society of Edinburgh*, the *Quarterly Journal of Microscopical Science*, and in other journals. His investigations have dealt mainly with Flagellata and other Protozoa

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THREE fellowships, each of the annual value of 200*l*. and tenable for two years, are being offered to graduates of the University of Wales. Particulars are obtainable from the Registrar, University Registry, Cathays Park, Cardiff. The latest date for the receipt of applications for the fellowships is May 31.

APPLICATIONS are invited for the Grocers' Company's research scholarships in sanitary science, each of the annual value of 300*l*. and an allowance to meet the cost of apparatus, etc, in connexion with the research carried out. The scholarships will be tenable for one year, but renewable for a second or third year under certain conditions. Forms of application (returnable not later than April 13) may be obtained from the Clerk of the Grocers' Company, Grocers' Hall, E.C.2.

FROM the Universities Bureau of the British Empire we have received a 40-page pamphlet containing lists of students from other countries in the universities and university colleges of Great Britain and Ireland, and of interchanges of teachers in 1924–25 between the universities of Great Britain and Ireland and those of other countries. A numerical summary of students from abroad discloses some interesting facts. The total number of the students in these lists is 4669. To this total Asia contributes 1718 (including 1301 from India, Burma, and Ceylon, 110 from China, 102 from Japan, 77 from Siam, 42 from Palestine, and 41 from Malaya), Africa 1150, America 815, and the Pacific 332. Of countries within the Empire, Canada and Newfoundland are represented by only 151, including 45 (chiefly Rhodes scholars) at Oxford, the West Indies, having no university of their own, send a much larger contingent proportionally to their population, namely, 139; South Africa and Rhodesia send us more than any other part of the Empire except India—716; from Australia there are 217, and from New Zealand 114. From foreign countries, the most notable contributions, other than those already mentioned, are: Egypt 351, United States 434, Russia 99, Germany 78, Switzerland 64, France 47 Of the universities most frequented by students from abroad, London is easily first with 2158 (including 673 in the medical schools). Next come Oxford 530, Edinburgh 525, Cambridge 493, Glasgow 207, Manchester 179.

Contemporary Birthdays.

February 27, 1864. Prof. Arthur G Green, F.R.S.
February 28, 1858. Mr. James Swinburne, F.R.S.
March 1, 1864. Prof. G H. Bryan, F.R.S.
March 2, 1870. Sir Frederick W. Keeble, F.R.S

Prof. Arthur G. Green was educated at Lancing College and University College, London. He was, from 1902–16, professor of tinctorial chemistry at the University of Leeds, afterwards director of research, British Dyestuff Corporation, resigning in 1923. Early in his career he was research chemist to a firm of aniline colour manufacturers in London, leaving to take up the post of chief chemist and manager of the colour works of the Clayton Aniline Co., Manchester. He has produced a number of new coal-tar colouring matters. For some years he was examiner in coal-tar products to the City and Guilds of London Institute.

Mr Swinburne was born at Inverness and educated at Clifton College. He was apprenticed at engineering works on the Tyne. Afterwards he was associated with Sir Joseph Swan in the erection and equipment of glow-lamp factories in Paris, and Boston, U S.A. In 1886 he took up the post of technical manager and designer to Crompton and Co., Ltd., becoming afterwards a consulting engineer. He was elected president of the Institution of Electrical Engineers for 1902–3. His inaugural address was entitled "Some Limits in Heavy Electrical Engineering." Mr Swinburne remarked that "the sort of tacit assumption that an engineer can never be a 'scientific man,' while a 'scientific man' can teach the engineer his business, cannot fail to annoy the engineer, and this feeling of annoyance is largely the cause of a great deal of opposition to technical, that is to say, really scientific education. The work of the electrical engineer is manifold. We should understand steam-engines, gas-engines, tramway matters, fuel questions, parliamentary matters, railway management."

Prof. Bryan, who has just resigned the chair of mathematics in the University College of North Wales, Bangor, was born at Cambridge and graduated at Peterhouse, of which college he is an honorary fellow. He was elected a fellow of the Royal Society in 1895 for his work and papers on thermodynamics and other branches of mathematical physics. In 1900 he was awarded the gold medal of the Institution of Naval Architects, for his paper "The Action of Bilge Keels." In the discussion on the memoir Mr R. E Froude described it as "most masterly" and a valuable contribution to the theoretics of rolling. Prof. Bryan is particularly well known for his pioneer mathematical work relating to problems of aeroplane construction and stability. In "Stability in Aviation," he brought together much original work on this subject, and the conclusions reached were of great value in indicating how exact knowledge of the principles of dynamical stability could be applied to the movements of aeroplanes He was awarded the gold medal of the Aeronautical Society in 1904.

Sir Frederick Keeble, Sherardian professor of botany in the University of Oxford, was educated at Alleyne's School, Dulwich, and Caius College, Cambridge. Formerly he was Assistant Secretary, Board of Agriculture (1919); Director of the Royal Agricultural Society's Garden, Wisley (1914–19); and editor of the *Gardener's Chronicle*, 1908–19.

Societies and Academies.

London.

Royal Society, February 18.—**A. Fowler**. The spectrum of ionised oxygen (O II). The spectrum of oxygen in the region λ 6750—λ 1850 has been investigated under different conditions, and particulars are given of about 400 lines which are attributed to the singly ionised atom (O II); 90 lines have been assigned to the doublet system and 68 to the quartet system. On the supposition that three of the doublet *p* terms form a Rydberg sequence, with 4R for the series constant, the value 93952 has been assigned to the term $2\,{}^2p_2$, and the values of other terms have been deduced. The term $2s$ thus derived suggests about 240,000 for the $1s$ term. The tabulated quartet terms depend upon an arbitrary value assigned to one of them. So far as a comparison can at present be made, the spectra of O II and N I, as expected, show a close similarity, the wave-numbers of several of the groups of lines in O II being approximately double those of the corresponding groups of N I.—**William A. Bone, F. R. Weston, R. P. Fraser**, and **D M. Newitt** · New experiments upon the combustion of well-dried carbon monoxide and oxygen mixtures. Pts I. and II As water vapour is progressively removed from a $2CO + O_2$ mixture, the 'minimum spark energy' necessary to fire it by condenser discharge sparks increases until, with a calcium chloride dried mixture, it becomes twenty-or thirty-fold as great as that required to fire it when saturated with moisture at 15° C A $2CO + O_2$ mixture, dried by six months' contact with pure phosphoric anhydride, can still be ignited and exploded, provided that a spark of sufficient energy be passed through it, although the gases display a much greater 'resistance' to combination than when even a minute amount of moisture is present. Phosphoric anhydride-dried $2CO + O_2$ mixtures can be easily exploded by increasing the pressure up to a certain point (5 to 10 atmospheres). The spectrum of the flame produced by the explosion of such a mixture at an initial pressure of 25 atmospheres, shows a continuous and diffused band spectrum, extending up to 2780 Å.U in the ultra-violet *without any 'steam lines' being discernible*. The conclusion is drawn that steam is not *essential* to the ignition and explosion of carbon monoxide and oxygen mixtures. Probably the ionisation of one (or both) of the combining gases is a necessary precedent to their combination, and the presence of even a minute quantity of steam promotes such 'ionisation.'—**W. A. Bone, D. M Newitt**, and **D. T. A. Townend**: Gaseous combustion at high pressures. Pt. VI. The explosion of argon- and helium-diluted knall-gases. In mixtures represented by $2H_2 + O_2 + 6R$, $2CO + O_2 + 4R$, and $2CO + O_2 + 6R$, where R represents helium or argon, at initial pressures of 10-150 atmospheres, in the hydrogen series, helium and argon act as monatomic diluents only, but in the carbon monoxide series, helium is also exercising some other influence.—**P. A. M. Dirac**: Quantum mechanics, and a preliminary investigation of the hydrogen atom. The quantum theory of multiply periodic systems is developed from the fundamental assumption that the dynamical variables do not satisfy the commutative law of multiplication, but satisfy instead certain quantum conditions. Applied to the hydrogen atom, it is necessary, in order to make the motion degenerate, to assume that the Hamiltonian of this system is the same function of the dynamical variables as on the classical theory when expressed in Cartesian co-ordinates, but not when expressed in polar co-ordinates.—**C. S. Beals**:

Quartet terms in the arc spectrum of copper A series of observations of the magnetic resolutions shown by copper arc lines has led to the identification, in the spectrum of copper, of a number of quartet terms. The combinations between the quartet terms give rise to a number of multiplets, and combinations also occur between some of the quartet terms and the previously determined doublet levels. This is the first instance of the spectrum of an element of the first group of the periodic table containing terms of multiplicity higher than 2. It is thus an exception to the general rule, that the maximum multiplicity of the terms in the spectrum of an element is 1 greater than the group number of the element in the periodic table. It also raises the question as to whether the previously held ideas concerning the atomic structure of copper are correct.—J. H. **Brinkworth**: The ratios of the specific heats of nitrogen at atmospheric pressure and at temperatures between 10° C. and – 183° C. The ratios of the specific heats are calculated from experimental measurements of the cooling effect in adiabatic expansion. By combining the results of experiments by Dixon, Campbell and Parker, on nitrogen at high temperatures, with Callendar's theoretical expression for the variation in the specific heats, values of these quantities at any temperature and pressure may be calculated.—W. R. **Dean**: The elastic stability of a corrugated plate. The elastic stability of a shallow corrugated plate under thrust along its generators is considered. The depth of a bay of the plate is assumed to be a small multiple of the semi-thickness of the plate; a formally correct solution of the equations of stability can then be found. The critical stress is determined from the vanishing of an infinite, but rapidly convergent, determinant When the ratios of depth of bay to semi-thickness are 5 and 10 respectively, critical stresses 30 and 130 times that of a plane plate of the same thickness and height can theoretically be obtained. The solution breaks down if the ratio of depth of bay to semi-thickness is too large, or if the corrugation is so rapid that the curvature is large. —E. **Newbery**: The controlling factors of transfer resistance The variations of transfer resistance due to condition of electrode surfaces and changes of current density have been investigated with copper, silver, gold, nickel, and platinum. Transfer resistance is made up of two parts: (1) The resistance of a film of gas over the electrode surface; (2) the resistance of a layer of partially exhausted electrolyte surrounding the electrode. It is almost independent of the chemical nature of the electrode, but is high with polished surfaces and low-current densities. At very high current densities it is very low, due to the increase of conductivity of the gas film, but is greatly affected by changes of concentration of the electrolyte. Overvoltage is essentially a chemical, transfer resistance a physical, phenomenon —R. L. **Smith-Rose** and R. H. **Barfield**: An investigation of wireless waves arriving from the upper atmosphere. Owing to the high conductivity of the earth, it was impracticable to distinguish between waves propagated horizontally along the earth's surface, and others which might arrive in a downward direction, after deflexion from the upper atmosphere. By repeating the experiments on shorter wave-lengths, these directional measurements made it possible to establish directly that, under certain conditions, a portion of the wireless waves arriving at a receiver comes from the upper atmosphere. Systematic experiments have demonstrated the arrival of wireless waves at night at angles of incidence from 13° to 34°, for a wave-length of 385 m. and a range of transmission of 77 miles. Assuming the simplest case of a wave symmetrically deflected from the upper atmosphere in its passage from transmitter to receiver, the height of the deflecting layer is about 88 km. Evidence was obtained during the experiments of the arrival of waves after two and three deflexions from such layer.

Royal Statistical Society, January 19.—R J. **Thompson**: The productivity of British and Danish farming Statistical comparison shows that the average output per 100 acres of agricultural land is more than 50 per cent. higher in Denmark than in Great Britain. As compared with Great Britain, Denmark carries a heavier head of stock in combination with a high arable area, and feeds this stock to a greater extent from her own soil, this is combined with higher yields. Costs of production in Denmark may be lower than in Great Britain owing to the co-operative purchase of feeding stuffs, etc., and to greater personal labour by the farmer, while Danish labour may be cheaper owing to longer hours and greater efficiency. The smaller size of the holdings (in Denmark some 56 per cent. of the cultivated area is in farms of between 37 and 128 acres, while in England and Wales some 53 per cent. of the area is in farms of 150 acres and upwards), combined with the psychological effect of ownership, is the primary source of the difference in the agricultural systems of the two countries.

Mineralogical Society, January 19.—C. E. **Tilley**: Some mineralogical transformations in crystalline schists. Attention is devoted to the pelite isochemical rock series with special reference to the mode of origin of the index minerals biotite, almandine, staurolite, etc., in crystalline schists. A fuller recognition of the element of progression in metamorphism brings inevitably in its train this genetic problem, hitherto greatly neglected. Mineral and rock analyses are graphically represented in triangular plots. Examination shows that the mechanism of the mineralogical transformations is something much more complex than is explained away by the customary simple equations. Further insight into the prevailing reactions depends very largely on a closer chemical investigation of these common metamorphic minerals occurring in the ground-mass of the crystalline schists.—A. **Brammall**: Primary gold and silver in the Dartmoor granite. Occurrences of minute flakes of native gold in the normal grey biotite-granite were shown to be independent of quartz-veins, tourmaline veins, and zones affected by pneumatolysis, and flakes occur as inclusions in felspar and quartz. A suite of assays of apparently barren tor- and quarry-granites, graphic granite, pegmatites, and vein pyrites shows that both gold and silver are widely distributed throughout the granite, the values ranging from 1-10 grains of gold and 1-161 grains of silver to the ton. A sample of biotite yielded 108 grains of silver to the ton. Both metals are undoubtedly primary.—A. F. **Hallimond**: On the chemical classification of the mica group. (ii.) The basic micas. In continuation of previous work on muscovite, the analyses of biotite and phlogopite are recalculated in molecular proportions, SiO_2 being made equal to 600. The ratio of potash is approximately constant, as in the acid micas. Values for the R_2O_3 and RO groups are plotted in a diagram which makes it possible to compare any new analysis with existing data. On this diagram biotite and phlogopite form a continuous series, covering a very well-defined area and separated from muscovite by a wide interval. The representation of alumina in the form of basic groups, AlO, etc., leads to the classification of the micas in a range of increasing acidity from muscovite to phlogopite. This arrangement corresponds generally with the gradation in acidity of the rocks from which the respective micas were derived. The micas can be represented either by hexasilicic or trisilicic formulæ; evidence from certain phlogopites somewhat favours the latter type.—**G. Greenwood**: The construction and use of an X-ray goniometer. Crystal-structure of glyoxaline compounds. A new form of X-ray spectrometer has been constructed. It embodies the principles of the optical goniometer. The crystal is mounted on a goniometer head rotating about an upper scale, and the adjustments are made optically by means of a telescope and collimator. In using the apparatus, a source of X-rays is used instead of a source of light and an ionisation chamber instead of a telescope. The ionisation chamber rotates round a second scale, concentric with the upper crystal scale. Small and transparent crystals are generally used and it is then possible to measure the crystallographic angles, *i.e.* angles between crystal faces or lattice planes of the structure, and in this way to make the ordinary angle measurements even when the faces are not actually present. It is also possible to measure glancing angles and spacings, and thus to make determinations of the space-group to which the crystalline structure belongs. Two substances were investigated: (*a*) Glyoxaline-4-sulphonic acid. The space group was determined and the crystal class—previously determined from the alternating presence of minute faces—was confirmed. (*b*) Glyoxaline. This substance does not form complete crystals. It was possible to measure crystal angles, and deduce the axial ratios, etc. The symmetry is monoclinic.

Geological Society, January 20.—**T. O. Morris** and **W. G. Fearnsides**: The stratigraphy and structure of the Cambrian slate-belt of Nantlle (Carnarvonshire). The Nantlle Slate-Belt is the south-western part of the outcrop of the Cambrian rocks of northern Carnarvonshire, which rest with appreciable unconformity upon the late pre-Cambrian volcanic rocks running south-westwards from Llanberis. A succession has been established by the mapping, and is constant in all its divisions along the length and strike of the district. It is argued that the Lower Cambrian sediments are land-waste from the pre-Cambrian rocks of north-western Carnarvonshire and Anglesey, whereas the latter Middle and Upper Cambrian material was brought in from an unknown source away to the east and south. Ordovician sediments are faulted against the basal member of the Upper Cambrian. A buttress of Ordovician volcanic rocks flanks the Nantlle area on the south-east side; but, within the area mapped, there are only altered dolerite-dykes, later than most of the impressed structures, to represent (and that a very late stage in) the cycle of Ordovician-Devonian igneous activity. The Nantlle district was deeply involved in the making of the Devonian alpine range, the basal wreck of which is now Snowdonia, and all sedimentary material within the slate-belt was compelled to fold, and then to crush until, both in bulk and in detail, it began to shear and creep. Cleavage in the slate-belt is almost vertical. More boundaries of slate 'veins' and quarry properties are determined by slides than by bedding-planes. Between slides the slate-beds have characteristic anticlinal structures, the synclines being suppressed. With removal of load by denudation, joints and other tensional fractures have appeared. The latest cross-faults are master-fractures, which traverse all other structures as also the pre- and post-Cambrian formations that flank the slate-belt. The direction of these is north of north-west, as the geometry of the half-dozen which cross the quarry-region suggests that block-movement was associated with northward shift on the eastern side of each. Petrographic evidence establishes the existence of secondary (authigenic) micaceous minerals with or without recrystallised quartz in all the rocks of the slate-belt, and especially in those slates which are of greatest economic value.

Optical Society, January 21.—**R. Kingslake**: The interferometer patterns due to the primary aberrations. In order to obtain a rapid estimate of the quality of a lens by observing its behaviour in the interferometer, it is necessary for the observer to be familiar with the characteristic patterns of the various primary aberrations under various conditions of adjustment. These patterns are easily calculated for any required case.—**J. Guild**: (1) A trichromatic colorimeter suitable for standardisation work. The three working primaries of the instrument are obtained by means of filters. The mixing of the primary colours is effected by a periscopic prism which rotates past three stationary sectors. Provision is made for adding any of the primaries to the colour under test, where this may be necessary in order to obtain a match. In this way colours of higher saturation than it is possible to match directly may be dealt with. (2) A criticism of the monochromatic-plus-white method of colorimetry. From the practical point of view of quantitative colorimetry, hue and saturation are not the fundamental elements of colour quality but must be regarded merely as derivatives of the trichromatic constitution of the colour. Whatever may be the advantage of specifying colour quality by hue and saturation, there are grave objections to practical methods of colorimetry involving the direct measurement of saturation. (3) On a new method of colorimetry. A new method and instrument are described for determining the quality of a colour, as defined by its position on the trichromatic colour chart, in which only the colour-matching properties of the eye are involved. The determination depends on two colour-matches in each of which the test colour is matched by a mixture, in unknown proportions, of a standard colour and a monochromatic colour obtained spectroscopically, a different standard colour being used for the two matches.

Physical Society, January 22.—**T. H. Laby**: Critical discussion of the determinations of the mechanical equivalent of heat. The principal recorded determinations of the mechanical equivalent of heat are critically discussed, and an attempt is made to correct them for errors not fully taken into account at the time when they were made. The results are weighted according to the relative importance attached to them by the author, and the weighted mean is given as 4·184 joules per calorie at 20°.—**F. Ian G. Rawlins**: The present status of theory and experiment relating to specific heats and the chemical constant. Possible lines of advance have been indicated for solids in view of the progress now being made in X-ray crystallography; further experimental work on compressibilities and elastic constants is suggested. Tentative views on the specific heat of liquids are given. In gases the quantum theory of rotational heat fails to account satisfactorily for the behaviour of hydrogen at low temperatures. The chemical constant of monatomic and diatomic substances is discussed and current views on its nature are described. The theory of gaseous degeneracy and its bearing upon specific heats and chemical constants is reviewed.

PARIS.

Academy of Sciences, January 18.—**Paul Marchal**: The conditions of aerial or subterranean life of the Aphides, and in particular of *Eriosoma lanuginosum*.—**M. d'Ocagne**: The classification of all the methods of calculation derived from geometry and mechanics.—**E. Mathias**: Contribution to the study of the fulminating material. The energy per cubic centimetre and per gram at the moment of explosion. The theory of globular lightning.—**Charles Jordan**: New formulæ for comparing two probabilities *a posteriori*.—**Julius Wolff**: The iteration of limited functions.—**J. F. Ritt**: Meromorph functions which admit of a theorem of addition of multiplication.—**G. Valiron**: A theorem of M. P. Levy.—**A. Liénard**: A generalisation of the spherical vortex of Hill.—**André Samuel**: A new electrical insulator. The condensation product of formaldehyde with cresol is arrested at the viscous stage and this product treated with sulphur chloride. The substance thus obtained is named thiolite and can be polymerised by heating under pressure. The material has a resistivity of 300×10^6 megohms per cm. and a dielectric constant of 4·5.—**Gustave Bessière**: A method leading to the production of 'peristereoscopic' images.—**L. Vegard**: The interpretation of the spectra emitted by solid nitrogen and by solidified mixtures of nitrogen and inert gases.—**Pierre Bricout**: The production of ultra-violet light by the impact of electrons of low velocity on the surface of a metal. A detailed account of an experiment giving evidence in support of the emission of ultra-violet rays of wave-lengths between 2300 Å.U. and 2100 Å.U. as the result of the bombardment of a metal surface by electrons.—**P. Pascal**: The magnetic properties of the carbonyl radical. The diamagnetic exaltation produced by nitrogen is further accentuated when it is substituted by a negative radical, and is clearly attenuated when it is substituted by a positive radical. From this it follows that compounds containing doubly linked oxygen are no longer inexplicable anomalies in the laws of additivity of diamagnetism.—**B. Bogitch**: Iron-iron sulphide alloys. From the experiments described it is concluded that no iron-iron sulphide mixture, melted in the absence of foreign substances, gives rise to the formation of two liquid phases.—**Francis Perrin**: Determinations of the average life in the activated state of fluorescent molecules.—**Al. Favorsky** and **Mlle A. Tchilingaren**: The dehydration of the α-glycols. Molecular transpositions of ketones into ketones. Phenylisopropylketone is transformed into methylphenylacetone under the influence of zinc chloride.—**M. Bourguel** and **J. Yvon**: The synthesis of some *cis*-ethylenic compounds.—**P. Fallot** and **R. Bataller**: The tectonic of the southern border of the basin of the Ebre and of the mountains of the Mediterranean littoral between Tortosa and Castellon (Spain).—**G. Mouret** and **E. Raguin**: The prolongation to the west of the zone of dislocation of Boussac (Creuse).—— **Rey**: The collection of a mineral water by the method of reciprocal hydrostatic pressures.—**H. Buisson** and **C. Jausseran**: The ozone variations of the upper atmosphere. Spectrographic observations were made daily at Digne (height 600 metres) under good conditions of atmospheric purity between July 24 and September 29. The average amount of ozone, expressed as the thickness in centimetres of pure ozone at atmospheric pressure, was 0·3 cm., in agreement with earlier results. The extreme variation was about 15 per cent. from the mean. These changes cannot be connected with the atmospheric conditions. In particular, the local barometric pressure is without influence on the variation in the ozone.—**E. Tabesse**: Magnetic measurements in the Loire basin.—**Garsaux**, **Malassez** and **Toussaint**: Vertigo due to rotation.—**C. F. Muttelet**: A method for distinguishing preparations of 'regenerated' dried peas from preserved fresh peas.—**Jacques Benoit**: Histological studies of the right genital gland of the fowl ovariotomised into a testicle.—**Jean C. Faure**: The relative specificity of polyphage parasitic insects.—**G. Ramon** and **Ch. Zoeller**: The antigen value of the tetanus anatoxin in man. The injection of the tetanus anatoxin in man is absolutely innocuous. As a result of the injection, some tetanus antitoxin is produced in the blood, but the amount varies in different men. The possibility of immunisation against the tetanus infection is discussed.—**C. Levaditi**, **S. Nicolau**, and **I. A. Galloway**: The passage of the virus of foot-and-mouth disease through collodion membranes.

Official Publications Received.

Aeronautical Research Committee. Reports and Memoranda, No. 964 (Ae. 178): International Trials. Report on Aerofoil Tests at National Physical Laboratory and Royal Aircraft Establishment. (A.3 a. International Trials, 6—T. 1698 and T. 1936.) Pp. 46+5 plates. 2s. net. Reports and Memoranda, No. 1000: The Lateral Control of Stalled Aeroplanes. General Report by the Stability and Control Panel. (D.1. Special Technical Questions, 186—T. 2110.) Pp 43+15 plates. 2s. net. (London: H.M. Stationery Office.)

The Newcomen Society for the Study of the History of Engineering and Technology. Transactions, Vol 4, 1923–1924. Pp. xi+168+21 plates. (London: The Secretary, Newcomen Society, Science Museum.) 20s.

Proceedings of the Royal Society of Edinburgh, Session 1925–1926. Vol 46, Part 1, No. 5: The Addition Theorem for the Legendre Functions of the Second Kind. By Dr. T. M. MacRobert. Pp. 30-35. 9d. Vol. 46, Part 1, No. 6 On the Theory of Graduation. By Dr. A. C. Aitken. Pp 36-45 1s. Vol. 46, Part 1, No. 7: The Theory of Continuants from 1900 to 1920. By Sir Thomas Muir. Pp. 46-70. 2s. Vol. 46, Part 1, No. 8: Electrosynthesis in the Series of Normal Dibasic Acids. By Dr. David A. Fairweather. Pp. 71-75. 9d. (Edinburgh. Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 18, N.S., Nos 10-16. 10: The Variations in the Quantity of Food required by Cattle for Maintenance and Production with different kinds of Rations (Second Paper), by J. Wilson; 11: Report of the Irish Radium Committee for the Year 1924; 12. A Contribution to the Geology of Great Orme's Head, by Dr. Louis B. Smyth; 13: The Action of Radon on Mixtures containing Ammonia and an Oxide of Carbon, by Dr. Kenneth C. Bailey; 14: Methods for Investigating the Virus Diseases of the Potato and some Results obtained by their Use, by Dr. Paul A. Murphy and Robert M'Kay; 15. An Examination of the Errors introduced by the various Approximate Methods used for Estimating the Total Quantities of Milk and Butter Fat produced during a Lactation, by M. J. Sheehy; 16: Preliminary Note on the Physiological Aspects of certain undescribed Structures in the Phloem of the Greater Yam, *Dioscorea alata*, Linn., by Dr. T. G. Mason. Pp. 117-198+plates 8-11. (Dublin: Royal Dublin Society; London: Williams and Norgate, Ltd.) 10s.

Agricultural Progress the Journal of the Agricultural Education Association. Vol. 3, 1926. Pp. 120. (London: Ernest Benn, Ltd.) 5s. net.

Department of Commerce: Bureau of Standards. Miscellaneous Publication of the Bureau of Standards, No 67: Kilocycle-Meter Conversion Table. 15½ in. × 11 in. (Washington: Government Printing Office.) 5 cents.

R Comitato Talassografico Italiano, Istituto Geofisico, Trieste. Memoria 110: La clorometria dell' acqua nelle indagini talassografiche. Per Dott. Mario Picotti. Pp 34 (Venezia: C. Ferrari) 1 50 lire.

The Story of Minerals. By Herbert P Whitlock. (The American Museum of Natural History, Handbook Series No. 12) Pp 144. (New York: American Museum of Natural History.)

Istituto Idrografico della R. Marina. Estratto dagli Annali Idrografici, Vol. 11. Campagna Idrografico-Scientifica nel Mar Rosso R.N. *Ammiraglio Magnaghi* 1923–24. Ricerche di oceanografia fisica. Parte 1ª: Correnti e maree. Per Prof. Francesco Vercelli. Pp. viii+188. (Genova.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 6, 1924. 5: Hydrografiska mätningar i Sverige Pp. 26+4 planscher. (Stockholm.) 5 kr.

Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 3, No. 5: De Svenska floderna vattenmängder. Av Gustav Slettenmark. Pp. 56+6 planscher. (Stockholm.) 5 kr.

The Carnegie Trust for the Universities of Scotland. Twenty-fourth Annual Report (for the Year 1924–25), submitted by the Executive Committee to the Trustees on 10th February 1926. Pp. iv+121. (Edinburgh.)

Department of Commerce: Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 298: Radio-Frequency Resistance and Inductance of Coils used in Broadcast Reception. By August Hund and H. B. De Groot. Pp. 649-668. (Washington: Government Printing Office.) 10 cents.

Ministry of Public Works, Egypt. Report of the Mission to Lake Tana, 1920–1921. By G. W. Grabham and R. P. Black. Pp. xix+207+55 plates. (Cairo. Government Publications Office.)

Diary of Societies.

SATURDAY, February 27.

North of England Institute of Mining and Mechanical Engineers (Associates and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—F. J. Johnston: The Use of Breathing Apparatus in Mines.—Paper open for Further Discussion—P. F. Hope: The Sinking of the Monkton Shaft.

Royal Institution of Great Britain, at 3.—Dr. G. Macdonald: Roman Britain (2).

MONDAY, March 1.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—Rev. B. N. Switzer: Some Biblical Discoveries relative to the Universe and its Origin.

Royal Institution of Great Britain, at 5.—General Meeting.

Society of Engineers (at Geological Society), at 5.30.—W. M. Beckett: Tidal Power on the River Severn—Some Notes and Suggestions on its Utilisation.

Institute of Transport (at Institution of Electrical Engineers), at 5.30.—H. D. Dickinson: State Ownership of Waterways.

Institution of Electrical Engineers (Western Centre) (at South Wales Institute of Engineers, Cardiff), at 6.—T. Carter: The Engineer: His Due and His Duty in Life.

Royal Institute of British Architects, at 8.—Lieut.-Col. H. W. G. Cole: The Paris Exhibition of 1925.

Aristotelian Society (at University of London Club), at 8.—G. D. H. Cole: Loyalties: A Study in Social Obligation.

Royal Society of Arts, at 8.—Dr. G. W. C. Kaye: The Production and Measurement of High Vacua (Cantor Lectures) (3).

Society of Chemical Industry (London Section) (jointly with Oil and Colour Chemists' Association) (at Chemical Society), at 8.—Prof. J. W. Hinchley, Dr. G. Martin, Dr. C. Beavis, C. A. Klein, and others: Discussion on Methods of Grinding.

Royal Society of Medicine, at 9.30.—Dr. G. Monod: From Cagliostro to Coué; or, Imagination as a Method of Treatment.

TUESDAY, March 2.

Royal Society of Arts (Dominions and Colonies Section), at 4.30.—Sir Basil Clarke: Publicity in relation to the Problems of Empire Settlement and Trade.

Royal College of Physicians of London, at 5.—Prof. W. W. C. Topley: Experimental Epidemiology (Milroy Lectures) (1).

Royal Institution of Great Britain, at 5.15.—Prof. J. Barcroft: The Egg (3). The Yolk.

Institute of Marine Engineers, at 6.30.—J. M. Lewis: Electrical Deck Machinery.

Institution of Electrical Engineers (East Midland Sub-Centre) (at Derby Technical College), at 6.45.—J. A. Aiton: Steam Pipes for Extra High Pressure and Temperature.

Institution of Automobile Engineers (at Royal Society of Arts), at 7.

Institution of Electrical Engineers (North-Western Centre) (at 17 Albert Square, Manchester), at 7.—J. L. Thompson and H. Walmsley: Notes on the Testing of Static Transformers.

Institute of Metals (Birmingham Local Section) (at Chamber of Commerce, Birmingham), at 7.—Dr. L. Aitchison: Light Alloys.

Royal Photographic Society (Pictorial Group), at 7.

Institution of Automobile Engineers (Coventry Graduates' Meeting) (at Broadgate Café, Coventry), at 7.15.—L. H. Dawtrey: Some Problems we Meet.

Institute of Metals (North-East Coast Local Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.—R. T. Rolfe: Bearing Metals.

Royal Anthropological Institute, at 8.15.—Mrs. J. B. M. McGovern: The Head Hunters of Formosa.

Röntgen Society (at Cancer Hospital), at 8.15.—Major C. E. S. Phillips: A Method of Increasing the Contrast of Shadows on Fluorescent Screens.

WEDNESDAY, March 3.

Royal Anthropological Institute (Edinburgh and the Lothians Branch) (at Royal Scottish Museum, Edinburgh), at 3.—R. Kerr: Demonstration on Recent Acquisitions in the Ethnographical Section of the Royal Scottish Museum.

Institution of Civil Engineers (Informal Meeting), at 6.—H. H. Lightfoot: Road Construction.

Institution of Electrical Engineers (Wireless Section), at 6.—R. A. Watson Watt: The Directional Recording of Atmospherics.—R. A. Watson Watt and J. F. Herd: An Instantaneous Direct Reading Radiogoniometer.

Institution of Heating and Ventilating Engineers (at Caxton Hall), at 7.—J. Meech: The Design and Application of Electric Motors relating to Heating and Ventilating Installations.

Institution of Automobile Engineers (Derby Graduates' Meeting) (at Cavendish Café, Derby), at 7.30.—L. A. Selvey: Permanent Mouldings and Die Castings.

Glasgow University Alchemists' Club (at Glasgow), at 7.30.—Prof. J. R. Currie: Iodine and Goitre.

Society of Public Analysts and other Analytical Chemists (at Chemical Society), at 8.—H. Droop Richmond and J. A. Eggleston: The Analysis of Acetic Anhydride.—A. L. Bacharach: Notes on the Determination of Moisture, Calcium, and Phosphorus in the Bones of Rats.—Dr. B. S. Evans and S. G. Clarke: An Accurate Method for the Determination of Mercury in Solution.—Dr. B. S. Evans: An Apparatus for Continuous Percolation and for Filtration in Neutral Atmospheres.

Royal Society of Arts, at 8.—P. Dunsheath: Science in the Cable Industry.

Entomological Society of London, at 8.—B. N. Schwanwitsch: On the Evolution of the Wing Pattern in Butterflies.

Royal Society of Medicine (Surgery, Medicine, Electro-Therapeutics, and Therapeutics Sections), at 8.30.—Prof. Mellanby, Prof. Fraser, Mr. Dunhill, and Dr. Salmond: Discussion on The Treatment of Exophthalmic Goitre.

Royal Microscopical Society (Biological Section).

THURSDAY, March 4.

Royal Society, at 4.30.—Sir Ernest Rutherford and others: Discussion on The Electrical State of the Upper Atmosphere.

Linnean Society of London, at 5.—The President: Abnormal Specimen of *Typha latifolia*.—E. Heron-Allen: The Iconography of a Myth: The Barnacle Goose.—C. J. Stubblefield: Development of a Trilobite, *Shumardia*.—Dr. H. G. Cannon: Development of the Fairy Shrimp.—H. W. Pugsley: Revision of *Rupicapnos* and *Fumaria*.

Royal College of Physicians of London, at 5.—Prof. W. W. C. Topley: Experimental Epidemiology (Milroy Lectures) (2).

Royal Society of Medicine (Balneology and Climatology Section), at 5.15.—Dr. F. G. Crookshank: Airs, Waters, and Places.

Royal Institution of Great Britain, at 5.15.—Dr. C. D. Ellis: The Atom of Light and the Atom of Electricity (2).

Child-Study Society (at Royal Sanitary Institute), at 6.—Dr. P. B. Ballard and Mrs. B. Drake: The Curriculum for Children from 11 to 14 years.

Institution of Electrical Engineers, at 6.—R. B. Matthews: Electro-Farming; or the Application of Electricity to Agriculture.

Institution of Mechanical Engineers (Glasgow and West of Scotland Branch) (at Royal Technical College, Glasgow), at 7.30.—S. H. W. Dawson: The Oil Engine: Its Weaknesses and Advantages.

Institution of Structural Engineers, at 7.30.—S. Bylander: Steelwork Specifications.

Chemical Society, at 8.—S. Sugden and H. Williams: An Experimental Study of Protective Colloids. Part I. The Influence of Concentration.

FRIDAY, March 5.

Royal Society of Medicine (Laryngology Section), at 5.—W. M. Mollison and others: Discussion on Atrophic Rhinitis.

Society of Chemical Industry (Liverpool Section) (Annual Meeting) (at Liverpool University), at 6.—Prof. I. M. Heilbron: Recent Investigations on Fish Oils.

Society of Chemical Industry (Manchester Section) (jointly with Institution of Rubber Industry) (Manchester Section) (at 16 St. Mary's Parsonage, Manchester), at 7.—W. J. S. Naunton: The Accelerator Action of the Di- and Tri-Arylguanidines.

Royal Photographic Society (Pictorial Group) (Annual Meeting), at 7.—M. O. Dell: The Use of Filters and Panchromatic Plates in Landscape.

Photomicrographic Society (at 4 Fetter Lane), at 7.—E. A. Robins: Parasites.

Junior Institution of Engineers, at 7.30.—J. M. Seddon: Tendencies in Modern Electric Practice.

Junior Institution of Engineers (at Engineers' Club, Birmingham), at 7.30.—C. H. Woodfield: Hoisting Appliances.

North-East Coast Institution of Engineers and Shipbuilders (Middlesbrough Branch, Graduate Section) (at Middlesbrough), at 7.30.

Geologists' Association (at University College), at 7.30.—A. L. Leach: The Dolmen Region of South-Western Brittany (Lecture).

Royal Institution of Great Britain, at 9.—Sir Henry Maybury: London Traffic.

SATURDAY, March 6.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: The Rare Gases of the Atmosphere and their Importance in Atomic Theory (1).

Gilbert White Fellowship (at 6 Queen Square, W.C.1), at 3.—Annual Conversazione.

PUBLIC LECTURES.

SATURDAY, February 27.

Horniman Museum (Forest Hill), at 3.30.—G. C. Robson: Squids, Cuttlefishes, and their Allies.

MONDAY, March 1.

University College Hospital Medical School, at 5.—Dr. R. A. O'Brien: Active and Passive Immunity. (Succeeding Lectures on March 5, 8, and 12.)

University College, at 5.15.—Prof. W. H. Lang: The Morphology of the Vascular Cryptogams in the Light of Pre-carboniferous Plants. (Succeeding Lectures on March 3 and 5.)

TUESDAY, March 2.

Middlesex Hospital Medical School, at 5.30.—Dr. G. Monod: Hygiene. (Succeeding Lectures on March 3 and 4.)

WEDNESDAY, March 3.

Imperial College of Science and Technology, at 5.30.—Prof. A. Sommerfeld: Atomistic Physics. (Succeeding Lectures on March 9 and 10.)

THURSDAY, March 4.

King's College, at 5.30.—C. J. Gadd: The Science of Divination (2).

SATURDAY, March 6.

Horniman Museum (Forest Hill), at 3.30.—Miss M. A. Murray: The Other World of the Ancient Egyptians.

SATURDAY, MARCH 6, 1926.

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A British Science News Service.

UNDER the auspices of the British Association and the British Science Guild, a conference was recently held to consider the advisability of establishing a science news service in Great Britain, and after discussion a small committee was appointed to carry the matter further. For some time such a service has existed in the United States, and the success achieved in that country encourages the belief that there is room in British newspapers also for accurate information on scientific subjects, narrated in such a manner as to be interesting to the average educated but unscientific reader. Matter which is suitable for the American reader is not necessarily suitable for the British: each nation has its own idiom and its characteristic outlook. But what American science can do for America, British science should be able to do, in its own appropriate way, for Britain. Already the *Morning Post* and one or two other British papers make a feature of admirable reports on scientific subjects, while a few specially gifted men of science are doing excellent work by furnishing the press with informative articles: but apart from these exceptional cases it is a commonplace that the great majority of newspapers fail to distinguish between science and magic in anything but name, that the space they allot to science, as distinct from sensational charlatanism, is negligible, and that such paragraphs as they do devote to scientific topics are for the most part meaningless and in many cases untrue. The sporadic efforts of a few gifted journalists are not adequate to meet the situation. What is needed is a systematic supply of news the accuracy of which shall be guaranteed by recognised scientific organisations, while its form renders it easily digestible by at least the better educated newspaper readers.

It is a curious fact that while it is considered socially disgraceful to be entirely ignorant of literature, a man's conception of the material universe he lives in may be that of a primitive savage, without his thereby incurring the smallest social stigma. Yet it is of vital importance to a modern State that its people should appreciate the value not only of the past achievements of science but also of its current enterprises. In his recent presidential address to the British Electrical and Allied Industries Research Association, Mr. Ll. B. Atkinson dwelt on the fact that Great Britain, which can claim credit for the fundamental discoveries in almost all the principal branches of science, has little or no vision of what could be achieved for it, in the material sense, by the adequate encouragement of scientific research: only by the cumulative effect of reiterated reminders, in the form of scientific news items in the daily press, can the lay public be brought to recognise the untapped resources of command over Nature to which scientific research holds the key. The material advantages conferred by science are, however, to some minds its least valuable gifts. As a means of culture, as a perennial source of interest and wholesome enjoyment, scientific knowledge is a boon which the layman is entitled to share up to the limit of his mental capacity, and the specialist who makes discoveries is guilty of unsocial conduct if he fails to impart his good fortune, so far as is practicable, to the rest of the community to which he belongs. Moreover, if the results of research are of value, its methods are of far greater value. Scientific knowledge differs from unscientific in its quantitative character rather than in its essential nature. It is pursued more systematically, it depends on inferences which are more cautiously drawn, its propositions are held as having assigned degrees of probability rather than as being 'true,' it is characterised by more complete candour, and it is more resolutely guarded against the influence which habit and emotion exert on the judgment. Most of the administrative problems of the world could probably be solved by the application to them of similar standards of thought, and the more fully the general public comes to understand the methods of science, the better will it apply them in the conduct of its own affairs. The value of scientific method as an intellectual model and a mental discipline is at least as great as the value of its industrial achievements.

It must, of course, be recognised that scientific topics are not all equally suitable for popular consumption. The bulk of the matter to be supplied to the press would presumably consist of descriptive accounts of the results of research. Such subjects as the relation of animals and plants to man, or the phenomena observed during an eclipse, can with a little trouble be made interesting to readers of quite moderate education. Into the jam provided by such attractive items could be inserted, with tact and discretion, a reasonable proportion of pills in the shape of references to experimental methods (these would be of particular interest to skilled mechanics) and to reasoning processes. The rather disproportionate interest which the lay public takes in scientific hypotheses might also be gratified with safety, provided that the nature and use of a hypothesis be repeatedly explained. In all cases an attempt should be made to give the facts in true perspective, the relative degrees of probability attaching to various results being carefully distinguished, and the relation between observation and conclusion explained wherever possible.

There is already a keen demand for trustworthy information of the type described, and it is a demand which could be greatly increased by the provision of a suitable supply. Probably if there is one subject less suitable than the rest for popular exposition it is Einstein's theory of gravitation, yet when this was 'featured' by the *Times* some years ago, the public responded with a thirst for information which created an excellent market for popular books on the subject. If, then, the most esoteric subject that could possibly have been thought of met with such an enthusiastic popular reception, there can be no doubt as to the 'news value' of really suitable material. One or two of the higher grade of newspapers already find it worth while to provide accurate science news, and this fact, combined with the experience of the United States, indicates that a science news service need expect little difficulty in creating a market for its wares.

Doubt is sometimes expressed as to whether satisfactory popular exposition is seriously possible, and whether a scientific truth can ever pass into the mind of an unscientific reader without undergoing such distortion as to render it a fallacy. This objection might be sufficiently met by mentioning a few of the names which have made the Royal Institution famous, but the matter deserves somewhat closer attention. Newspaper readers are not a homogeneous class. Some will only be capable of following the simplest descriptive matter, but for the rest the improved teaching of science in schools is bringing into existence year by year a growing class of men who are quite familiar with the fundamental conceptions underlying modern science, and only need the stimulus of a daily news paragraph to enable them to resist the atrophy of their intellectual equipment.

Further, the difficulty of understanding scientific books and papers arises only in part from the intrinsic difficulty of their subject matter. It is beyond dispute that the published records of research are often extremely badly written. They abound in slovenly sentences giving rise to ambiguities which can be solved only by special knowledge on the part of the reader. They present ideas in a haphazard order which makes assimilation difficult. They omit to elucidate conceptions which are familiar to the author, but require explanation for the benefit of the less specialised reader. They fatigue the mind with the elaboration of minor details, and fail to focus attention on the really important parts of their subject matter.

The skilled scientific journalist, who mixes with the world in general sufficiently to understand his public, will avoid these faults. He will also know what to take for granted and what to explain, when to use a technical term and when to translate it. He will illustrate general principles by particular examples, and explain obscure conceptions by means of such analogies as are helpful and not misleading Above all, he will repeat his more important statements, varying their form and context, often enough to make sure of their being fairly grasped. Charles Darwin showed what can be done by a man who is himself clear-headed and takes the trouble to write simply, directly, and with a sympathetic regard for his reader's difficulties in comprehension. The "Origin of Species" consists largely of close and difficult reasoning, yet it is probably one of the most widely read and best appreciated books of its century. It should be the duty of any news service which may be instituted to provide day by day the kind of authentic yet digestible interpretation of science which such writers as Darwin have definitely shown to be attainable.

The committee which has been formed will be confronted with a number of difficult problems, which will have to be solved before success can be achieved. Perhaps one of the most difficult will be that of guarding the news against mutilation by unscientific sub-editors. On the other hand, there is little to be feared from the alleged hostility of the pioneer journalists who are already in the field. It is to the interest of all concerned to co-operate in creating an increased demand for science news, and it is therefore reasonable to hope that the parties in the case will agree to pool their assets, which are, on one side, experience and an established reputation, on the other, the prestige of scientific authority.

Without the willing assistance of scientific workers and institutions, no organisation for the preparation and distribution of science news can possibly be successful, and even with it, there is little hope that the agency would be self-supporting for several years. As regards finance, it may be mentioned that the American service pays for itself to the extent of about 60 per cent. of its expenses, the remaining 40 per cent. being provided by endowment. It has been estimated that a British service, selling news at standard rates, would need an endowment of at least 5000*l.* to ensure its being able to run for three years, at the end of which time it should be possible to decide whether the support secured was sufficient to justify the continuance of the service. One of the questions before the committee which has been set up is that of the possibility of raising this sum by contributions from public-spirited donors or other sources. It is unnecessary to discuss here the contrivance of machinery for obtaining and supplying news, but on the assumption that this and the other tasks confronting the committee can be successfully carried out, the scheme in its broad outline is one which must commend itself to every man of science who appreciates the significance of the discipline with which he is associated. C. W. H.

The University of London.

University Reform in London. By Thomas Lloyd Humberstone. Pp. 192+4 plates. (London: George Allen and Unwin, Ltd., n.d.) 7*s.* 6*d.* net.

THE signing of the Locarno Pact and the settlement of the Boundary question in Ireland can scarcely have failed to raise hopes in sanguine minds that, in such days as these, even the University of London difficulties may at last meet with some satisfactory solution. A Departmental Committee of the Board of Education, appointed in 1924, is at work. It is sitting behind closed doors, but it is understood that evidence has been taken and that before long we may have the Report. It is certain that when the Report does come, it will be read with the utmost interest and examined with the closest scrutiny by all who are interested in British university education.

With this prospect before us there comes to hand in the most timely way a book that will be invaluable in supplying to all who seek it a compact and readable account of the history of the University of London. Mr. Humberstone calls his book "University Reform in London," and he writes not merely as a chronicler but as one imbued with a zeal and a policy for reform. In such circumstances, it is not easy for a writer to present an undistorted tale of history, but, though the reviewer differs from Mr. Humberstone on a number of questions, he has no single word of complaint to make of prejudice or distortion. On the contrary, he is grateful for an historical summary that is at once accurate and alive, far removed in style from the monotonous correctitude of the civil service essays in which so much of our authentic educational history is—perhaps necessarily—enshrined. One is impressed but not oppressed by what Mr. Wells calls the high sincerity of the writer; he has a literary gift, a light touch, and an engaging frankness that greatly help the march of his story. Where he is adding his own comments or expressing his own views, it is plain to the reader, and it is quite refreshing to have here and there some serious proposal stigmatised as preposterous. The size of the book, the print, and the three aircraft plates of Bloomsbury, South Kensington, and King's College, are admirable.

For an adequate appreciation of Mr. Humberstone's outlook, the reader must be referred to the book itself; it must suffice to say here that he expresses strong opinions about the restoration of the Royal College of Science at South Kensington (the "Imperial College" being left for technology), and he is strongly in favour of full development of Bloomsbury as a university quarter. On the whole his counsels are those of moderation, and he seems quite hopeful of harmonious co-operation being achieved in the University without any subversive constitutional change.

The University of London is so complex, the individual knowledge and interests of those who criticise so varied and often so partial, that it appears less presumptuous to speak about it in the first person singular than to usurp an editorial "we," and in what follows that course will be taken.

I have had for nearly half a century a close interest in the University of London. As a student of chemistry at Owens College, Manchester, I became indebted to it as affording me the sole available means of obtaining a university degree. In early life I was thrown much among men with whom, in the days of religious tests at Oxford and Cambridge and the neglect of science there, the University of London stood for emancipation, freedom, and progress. It gave a university franchise to a vast section of the community suffering from a genuine grievance; it was subserving the development of the new universities that have arisen in our great cities; and it gave university privileges to women. It must be difficult for the younger generation to-day to understand the intensity of feeling which lay behind and still in a measure survives in the external examining service of the London University. People have wondered how, for example, Convocation can ever have claimed so great a say in the University affairs; but it is easy enough for Victorians to understand—whether they approve it or not.

During the modern period of university development, the new universities in the provinces have, of course, been watching one another very closely, but they have been watching, not less closely, the University of London. What London does matters very much to them. There are two chief reasons for this. In the first place London seems from a distance to stand in more danger than any other university of coming into the toils of Government and bureaucratic control. In the second place, there is the possibility of London having ascribed to it duties or privileges of a metropolitanism and even an imperialism for its University, because London is the capital of England and the chief city of the Empire.

Of these questions I will only refer to the first, and on that little need be said in the columns of NATURE, for most of its readers will know how deep and intense in the English university world is the feeling that freedom and autonomy are beyond all else vital to a true university. They know that the possible encroachments of Government or other bureaucratic authority on university preserves even in England have called for constant vigilance. They know also the peculiar position the University of London has occupied in relation to the Government—or if they do not they will learn it from Mr. Humberstone's book.

Apart from the two special questions that I have named, there has naturally been great interest among those engaged in the newer universities in watching the efforts that have been made in London to achieve the stupendous task of welding into a genuine university the array of varied institutions which were providing studies of the university type. As a problem of organisation and administration, it is unique in magnitude and complexity, and in the purely educational aspect it is fraught with complications and difficulties of a quite peculiar kind. A smooth course of construction, a rapid achievement of unity, could not be expected by any reasonable person.

The University of London is bound, *ipso facto*, to be great in one sense, and it may easily be made great in external appearance by the aggregation of buildings and the creation of an imposing University quarter. But of course the real difficulty is to supply not the body but the soul to a University of London. We can conceive what might have been now if there had been in early times a true University of London, and if this University, growing up *pari passu* with the growth of London itself, had become scattered into such discrete and distant parts as those now comprised within the University. The parts would have had a genetic relationship, and there might well have been preserved among them, even within this modern community of more than ten million people, a reality and sense of University fellowship, a pride strengthened by time and tradition in being members of a great learned and humanising corporation in the metropolis of the Empire. We may conceive that in its specialist institutes and single schools, in its social amenities of clubs and parks, there might have been strong agencies for promoting a collective university spirit. But the University, even if in substance and action little more than a name, might have remained an august and genuine *Alma Mater*.

To bring together the constituent parts, as they were at the inception of what is known as the teaching University of London, and to imbue them instantly with any of the spirit which has just been referred to, was certainly not to be expected. I confess to having considered the problem to be well-nigh hopeless and to have been inclined to think that the most likely solution of the University question in London would lie in the creation of several completely independent universities. This state of mind arose from my experiences and instincts as a university teacher and the apprehension I felt in observing how strong seemed the faith in some minds that a University of London was to be created by mere aggregation—by catching and binding institutes and teachers into an examinational nexus, and by creating a machinery of organisation, co-ordination, and administration that together promised to make the life of a university teacher in London scarcely worth living.

I am happy to say that recent events have modified my opinion. The decision of King's College to remain where it is and to abide by limitations of space and numbers whilst making itself as good as it can be, was announced in June last in the *Times* by a letter from the Principal, Dr. Ernest Barker, which rang with a clear and arresting note. The Imperial College, under its new Rector, Sir Thomas Holland, has also apparently by a shrewd stroke reached a condition of contented life within the University circle. This trend of opinion and action seems to give good hope for the future. I am one of those who believe that a strong individual life of colleges must, in London as in Oxford and Cambridge, underlie any real strength of the university, and that it will be in keeping the official bonds within the university as light as possible that we may hope to see them grow strong. The *Lehrfreiheit*, of which perhaps we are rather tired of hearing, is after all a very serious aspiration, and equally serious are the susceptibilities of important public men, who give time and labour voluntarily to the management of individual colleges.

I believe that here, as in so many other corners of our educational world, the root of trouble is to be found in the false attributes which have been put upon university degrees. The apprehension that the freedom of a college will be associated with a laxity of academic standards is of course the natural view of the man in the street, but it is still felt also to some extent within the teaching world itself. People seem to forget how wide and influential an educated public opinion has arisen in the course of the last generation. It is perhaps more difficult in London than elsewhere to realise what an array of educational officials, what multitudes of headmasters and other teachers trained in the modern universities, are now watching all the universities and colleges, and how quick and effective is their detection of any shortcomings. Not much is said aloud, but there is a closeness of scrutiny and a silent appraisement in existence that make little of examination syllabuses or lists and go right to the heart of things. I am certain that the new universities in the provinces are sensible to-day of an intelligent and mute surveillance which is constantly and justly estimating their sterling value and letting it be known wherever such knowledge matters. I believe that the danger of London colleges under-bidding one another in their courses for a degree need in these days cause no anxiety. The question that will more and more be asked of London graduates will be, as it now is with the initiated, not whether they have an honours degree, but how, where, and by whom they were trained.

It was my fate to work for seventeen years in the bonds of a federal university wherein three colleges were acting together, linked closely in a degree system intended to preserve a uniform academic standard and a just classification of graduates. The condition was of course a great improvement on that of wholly external examination, and no doubt the teachers of the different colleges gained a good deal from intercourse and discussion in Boards of Studies and in their joint examining. But many of us felt the restrictions to be very serious, and in the following years of liberty the University of Leeds, and I think it is equally true of Manchester and Liverpool, has worked to more valid and really higher standards and has dispensed its honours with much greater justice. I see no reason why the disbanded colleges might not have obtained much, if not all, of this freedom and still have remained in name members of a Victoria University if there had been any strong practical or sentimental motive for such a union. But the case is of course different with the colleges and institutions in London. Here, there are both an obvious and compelling argument for inclusion under one university name and the geographical possibility of collective university action in the creation of special institutes and in bringing into common account the great and unique treasury of resources which London can contribute to university studies. The prospects for the teaching University of London appear to me to-day to have grown very sensibly brighter.

For the externally examining agency I can see a useful place if it be disentangled from the teaching university. Until the provision of universities in the country is completed, there will still be some developing colleges seeking the mark of a degree for qualified students. They had surely far better come to London, as of old, instead of trying to stir the new universities in the provinces to begin upon the work in which London is so well practised. Besides this there are, no doubt, and may be for a considerable time, a good many individual hard cases that are met by the externally examining system. But there is one thing that even the most devoted of the old guard of the external side of the University of London must now recognise; it is that the strength of opinion which has been steadily growing against completely external examining from top to bottom of our educational system, is now overwhelming, and that the external degree of London cannot escape the consequences.

The short preface which Mr. Wells contributes to

Mr. Humberstone's book is written in a vein of striking earnestness. Mr. Wells is of course one of the most distinguished beneficiaries of the old examining agency that bore the device of a university. The outlook which he now takes is, I think, very much the same as is taken in this article. If all of us who owe so much to the system that had its day and is ceasing to be, can readjust our loyalty as fairly as Mr. Wells has done to the system that must now succeed it, we should be doing a great good turn for a true University of London.

A. SMITHELLS.

Industrial Distillation.

Principles and Practice of Industrial Distillation. By E. Hausbrand. Translated from the fourth, new and enlarged, German edition by Dr. E. Howard Tripp. Pp. xx + 300. (London: Chapman and Hall, Ltd., 1925.) 21*s.* net.

THIS translation of Hausbrand's "Die Wirkungweise der Rektifier und Destillier Apparate" is a welcome addition to the comparatively small number of text-books on distillation which are available in the English language. As the original work has attained the rank of a standard treatise in the country of its origin, where it has reached the fourth edition, and as it is well known in other countries to those who can read German, it is rather surprising that a translation has not been attempted before now. As publication, however, although delayed, supplies an obvious want, there is no doubt that the book will find its way into the hands of many readers to whom it should prove of great service and interest.

Hausbrand's analysis of the various processes which occur in the distillation apparatus has the peculiar merit of avoiding any use of the calculus, and in this respect his presentation of the subject will appeal especially to those readers who are confounded by the integration which is so frequently employed by other writers. On the other hand his methods, although easily understood by the non-mathematical student, would appear to involve a great number of calculations. It is true that the results of such calculations for eleven of the best known mixtures are given in tabular form with great detail and for a variety of conditions such as are met with in practice, yet for other pairs of liquids than these, the necessary work would be both tedious and time-consuming compared with that required in the graphical integration which is such an important feature in other methods of analysis. Throughout by far the greater part of the book, the author has very wisely employed percentages by weight instead of the molecular percentages so much beloved of other writers. In the small section devoted to the calculations of the vapour composition curve, molecular fractions and percentages are employed quite correctly because they are essential, but their introduction into any analysis which purports to be of a more or less practical nature is not only confusing but also in the majority of cases quite unnecessary.

The extensive tables and accompanying graphs which form such an important feature in the book are very instructive when studied in connexion with the text. It must, however, be remembered that, as with all other methods of analysing distillation processes, it is necessary to assume that equilibrium conditions hold between a mixture and its evolved vapours. As such conditions do not exist in the working column, it is necessary to apply a correcting factor to the results obtained by using either Hausbrand's or any other method. This does not detract in any way from the great value of the book to all those engaged in practical or academic work connected with distillation. It does point to the need of establishing the relationship between the number of plates in a perfect and in a working column for different values of the reflux ratio and different initial and final concentrations of the mixture to be distilled.

There are some parts of the book where the author has preferred to calculate tables by first evolving somewhat fearsome formulæ, whereas a simple example would have saved time and trouble. For example, to arrive at the alcohol content of the residual liquid (Section 11, pp. 36 *et seq.*) several pages are devoted to evolving two equations by which the data given in Table 4 are calculated. The necessary calculations are, however, so brief and simple that the section seems redundant or, at least, could be severely compressed and explained by one example occupying a few lines. In some other directions similar remarks might be made. Viewed as a whole, the work is of considerable practical utility and contains a wealth of information which can be studied with advantage in connexion with plant on the works scale. In the first part of the book the underlying principles are explained, and in the second part is given the application of these fundamentals to the calculations of the required dimensions of fractionating columns. The work is a classic which has found great honour in its own country. In its English version it should be read by all those interested in the subject of distillation.

The translator, while remaining faithful to the sense of the original, has succeeded in his object of producing an English work free from the style and the long involved construction which are so peculiarly German and must considerably perplex those who are imperfectly acquainted with the language. The reviewer, having read the original, can appreciate the excellent way in which the lengthy periods so common in German scientific and technical literature have been rendered into easy flowing English. The original work contained a great number of mistakes especially amongst the suffixes, but these have been carefully corrected. In the translation very few are to be found and none of importance; 0·35 instead of 9·35 in Table 4 would not lead any reader astray. On p. 12 on the bottom lines, "must rise with" would be more correctly translated as "must rise within" (*innerhalb*) or "as part of." All such criticisms are, however, of very slight weight. Printing, binding, etc., are excellent, and improvements on the original.

C. ELLIOTT.

Biology of Cancer.

Tumors and Cancers: a Biological Study. By Hastings Gilford. Pp. xii + 703. (London: Selwyn and Blount, Ltd., 1925.) 42*s.* net.

MR. HASTINGS GILFORD has approached his subject as a biological study, a point of view which has received comparatively little attention from those engaged in cancer research. In a very exhaustive survey, the author discusses the natural history of tumours and their relation to normal and abnormal growth and development. Development is considered as a cyclical movement, a progression followed by regression, and Mr. Gilford believes that cancer ensues when certain cells complete their developmental cycle prematurely and are roused into regressive activity by stimuli; it is thus essentially of intrinsic production and a disorder of development.

It is a little unfortunate that this book was published before the description by Gye and Barnard of their recent work in cancer research, to which at first sight Mr. Gilford appears to be in direct opposition. Had the book appeared a year later, more consideration might have been given to the possibility that micro-organisms could play a part in stimulating cells into regressive activity. In all diseases which are due, or probably due, to bacteria, there are two factors to be considered: they are the causal microbe and the relative immunity of the body. Lack of methods for better understanding of the latter has driven research in infective diseases into search for and study of the nature of the microbe, and it is only recently that predisposing causes have begun to be thoroughly investigated.

To some extent Mr. Gilford's book provides a review of the predisposing causes of cancer, and so far he is not at variance with other workers on the problem. Where he definitely departs from the trend of modern research is in considering the real source of cancer as essentially intrinsic. Tuberculosis is just as much a reaction of the body as is cancer, though we now know it to have an external cause, which, however, is negligible if the body is completely immune. The problem of cancer will not be solved until there is full understanding of the exciting causes as well as of the steps by which healthy cells change to form a malignant colony.

Mr. Gilford's view of cancer as essentially a developmental error leads him through an interesting survey of the sins of personal and racial life which predispose to such error. Thus he sees at the root of malignant disease our national state of "accelerated or premature senescence," and associates it with a spirit of diffidence and indifference in facing our social problems. While the cure of our political ailments and the removal of our personal errors of living may not eradicate cancer, nobody will fail to agree with him in his plea for a better form of civilisation and conformity to the rules which promote a higher standard of individual and national health.

Our Bookshelf.

Practical Physical and Colloid Chemistry: for Students of Medicine and Biology. By Prof. Leonor Michaelis. Authorised Translation from the second German edition by T. R. Parsons. Pp. x + 195. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1925.) 7*s.* 6*d.* net.

THE English translation of this very useful book is to be cordially welcomed. Although it is intended for students of medicine and biology, and many of the examples in it are selected accordingly, the student of general colloid chemistry will derive considerable benefit from working through the greater number of the exercises. The very first chapter gives a much clearer account of the principles of serial experiments—which play so important a part in the study of electrolyte coagulation and of adsorption—than is to be found in the existing laboratory manuals. The application of these principles is thoroughly illustrated in the subsequent exercises on electrolyte coagulation and on the Hofmeister series. The author, in common with all European authors, appears to be quite convinced of the reality of the anion effect, in spite of J. Loeb's criticisms, and, following Wo. Ostwald's example, demonstrates it with hæmoglobin instead of the usual egg or serum albumin. The chapters on the determination of hydrogen ion concentrations are excellent, and a student who has mastered the one entitled "Units and nomenclature" ought to have no illusions on the accuracy of statements like "*p*H 4·3 to 4·6," and should be able to state either offhand in gram-ions per litre. Viscosity is treated somewhat briefly, and some exercises on sols other than that of gelatin would have been instructive. On the other hand, the sections on surface activity and on adsorption—on which subjects the author has done much original work—contain a number of very ingenious experiments not to be found in other manuals.

The translation is unusually good, and it is a pleasure to read an English rendering of a German text in which no hyphenated nouns and compound adjectives have been allowed to intrude. The translator might, however, have considered it part of his functions to restore a victim of the German mania for phonetic spelling like "Tindall" to its correct form, and even in these degenerate days he should have given the participle of *adjuvare* its proper termination instead of making it "adjuvent."

Principles of Genetics: an Elementary Text, with Problems. By Prof. Edmund W. Sinnott and L. C. Dunn. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Pp. xviii+431. (New York: McGraw-Hill Book Co. Inc., London: McGraw-Hill Publishing Co. Ltd., 1925.) 17*s.* 6*d.* net.

THIS book is intended to be used by first-year students taking an introductory course in genetics, and appears to be well adapted for the purpose. It is pleasantly and clearly written, the numerous illustrations are well executed, and the authors have succeeded in obtaining a fair proportion which are not already over familiar. An innovation in this class of book is the introduction at the end of each chapter of a number of "Questions for Discussion," of "Problems," and of what are termed "Reference Assignments." Of these, the problems are on the whole excellent, and, to the student who conscientiously works through them, should provide a good test as to whether he has fully grasped the subject matter on which they are set. They should also prove useful to the teacher. The reference assignments are perhaps intended for more advanced students, for many of them seem too difficult for elementary ones.

If, as is likely, a second edition of the book is called for, the authors should pay a little more attention to their historical sketch, and to the crude diagram on p. 6. Genetics is here shown emerging from the "Dark Ages" with the discovery of spermatozoa by Hamm in 1677, as though the names of Harvey and de Graaf had no significance for students of this science. Nor was the function of the sperm discovered by Spallanzani about 1700, for at that time he was not even born. To Camerarius too should be given some credit in the discovery of the process of fertilisation in plants. And why should not Buffon and Erasmus Darwin be mentioned in connexion with theories of evolution? The dates after some of the names evidently refer to a famous publication such as Darwin, 1859, Mendel, 1865; but why should 1779 be assigned to Knight, who was then a young man of twenty years with nothing particular to his credit? We agree that a brief historical sketch might well be both interesting and illuminating, but to be of any real service, it must be more accurate and more comprehensive than what is given here.

Graphical Methods of Plotting from Air Photographs. By Lieut.-Col. L. N. F. I. King. Pp. 92. (London: H.M. Stationery Office, 1925.) 3*s.* net.

THE rapid development of aerial navigation has opened the door to a number of new subsidiary possibilities, not the least of which is the mapping and surveying of large areas from air photographs. Generally speaking, the problem is twofold. It is concerned in the first place with the scientific conditions under which the photographs are to be taken and the scientific machinery, camera, lens, plates, etc., for effecting this. In the second place, it is concerned with the principles and methods that have to be devised for the accurate interpretation of these photographs in terms of an exact geometry of the landscape. The present collection of notes deals with the second aspect of the question, not as a dogmatic treatise on the subject—it is too early for that—but as a record of graphical processes that may be utilised in the analysis and synthesis of such photographs and the geometrical principles upon which such processes depend. It is not claimed that for this purpose graphical methods are necessarily superior to other possible methods of a mechanical or a photographic nature, but that many cases must occur both in peace and war where individual and tilted photographs must be made to yield their secrets, and the graphical processes described in this work will do it.

There are many parts of this interesting subject that might with advantage be incorporated into a course on perspective and descriptive geometry, and teachers of this subject would do well to examine this little book. One word of criticism. One does not require to be a purist to object to the word "photo," especially when it alternates with "photograph," so that no new significance is attached to it. Its frequent appearance on every page of this Government publication does not convert it into the King's English.

Chemistry to the Time of Dalton. By E. J. Holmyard. (Chapters in the History of Science, 3.) (The World's Manuals.) Pp. 128. (London: Oxford University Press, 1925.) 2*s.* 6*d.* net.

To the majority, perhaps the vast majority, of trained chemists, the history of their subject is practically a closed book, partly because they lack the historical sense, but also because they have been repelled by the manner in which the subject has been presented. To write a readable history of chemistry that will appeal to the practically-minded is no easy task; alchemy, with its lure of gold, has always a certain fascination, but the symbolical writings of its devotees are painfully dull to all except the specialist; and the long-drawn-out controversies of later times on views that are now held to be mainly erroneous are no less wearisome. To those who have passed through the mill, or have been arrested at its threshold, Mr. Holmyard's little book will be heartily welcomed as a successful attempt to present in bold outline a history of the development of ideas which have played a great part in the elaboration of modern chemistry, notably those on the constitution of matter and on the nature of combustion; and the author's original work on the gropings of the early Muslims will add a spice of novelty to what is usually regarded as dull and indigestible. Specialists will naturally ask for a more detailed treatment than that here presented, but they also will read with pleasure and profit this valuable introduction to the subject. The book is well written, profusely illustrated, and remarkably cheap.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Loculus of Archimedes.

IN the course of study, of a totally different subject, I recently came across reference to a pastime of the ancient Greeks and Romans, which was of the same nature as the Chinese puzzle, or Tangram, though more elaborate. Curiosity being excited, the scattered references were hunted up, and it was found possible to reconstruct this puzzle with practical certainty, though I have not been able to discover that this has previously been done. From the manner in which this has been received, by those who have seen it, the subject appears to be of sufficient general interest for the result to be placed on record.

To this puzzle the Romans applied the name of *loculus Archimedius*, the first word meaning a small receptacle divided into compartments, the second referring to the name of the reputed inventor. The Greek name is uncertain; the lexicons give it as *ostomachia*, but the only authority quoted is the Latin writer, Ausonius, and this is the form usually adopted by the editors of the printed texts, though the word is sometimes given as *stomachia*. The question of the choice between these two forms was discussed at length by Prof. J. L. Heiberg, in 1907 (Hermes, *Zeitsch. f. class. Philol.*, 12, p. 240), who concluded that the first named, usual, form is a mistaken emendation of the editors, and that the other is the correct one; it is also the form found in a palimpsest, deciphered by him in 1906, and the only known occurrence of the word in a Greek manuscript. If ostomachia is correct the interpretation would be a battle or struggle of bones, while stomachia, or stomachion, would mean the thing that drives one wild.

The descriptions of the Latin writers, being in each case a parenthesis, in illustration of a very different subject, are naturally incomplete, but they show that the puzzle consisted of fourteen pieces of ebony or ivory, mostly in the form of triangles of various kinds and descriptions, with some pieces of a larger number of sides, which were combined to form pictures of fearsome elephants and barking dogs, of ships, castles, and many other objects, but, adds Ausonius, though the compositions of the skilled are wonderful, the efforts of the novice are ridiculous. To this all that can be added is that the whole set was contained in a *forma quadrata*, an expression which, like its English equivalent, square, in geometry implies equality of the four sides, but, in literary or colloquial language, need mean no more than a rectangle.

These descriptions, though they give a good general idea of the puzzle, are no help to a reconstruction of it; of this the first information became generally available in the publication, by H. Suter, of the text and translation of two Arabic manuscripts, preserved in Berlin (*Abh. z. Geschichte d. Mathematik*, 9, 1899, pp. 493-499). The Arabic text is itself a translation from the Greek and is entitled the book of Archimedes on the division of the Stomachion into fourteen parts; it contains a description of the construction, followed by a demonstration of the relation of the area of each separate part to the whole. The translation is illustrated by a figure, reproduced in Fig. 1, which appears to be a reconstruction by the translator, as no mention is made of any figure appearing in the manuscript, and two similar manuscripts, in the India Office and Bodleian libraries, are both wanting in the figure, for which a space is left. The construction may be briefly described: the figure ABGD, drawn as a square but described in the Arabic as a parallelogram, is divided into two equal parts by the line EZ, parallel to AB; the diagonals AG, BZ, ZG are drawn; AL is bisected in M, and BM joined; BE is bisected in H, from which HT is drawn parallel to AB, and HK as part of the line joining HA; ZG is bisected in C, and DG in N, and EC, CN are drawn; finally CO is drawn in continuation of BC; the whole figure being thus divided into fourteen parts.

This interpretation appears to have been accepted by scholars as a representation of the loculus, but an examination throws doubt on this conclusion. First there is the practical difficulty that it gives a number of very acute angles, which would not only need skilled and careful workmanship to produce, but the razor edges resulting, in one only just over 11°, would be too brittle to stand usage, and would rapidly become damaged. Secondly, a comparison of the translation with the Arabic text shows that while, in the former, the outer figure AG is described as a square, and the two halves AE, ED as rectangles, the latter consistently uses the same word, which means no more than a parallelogram; and in this the Arabic is logically correct, for it treats the subject as an exercise in pure geometry, and the construction, together with the subsequent discussion, is equally applicable to any parallelogram, irrespective of the magnitude of the sides or angles.

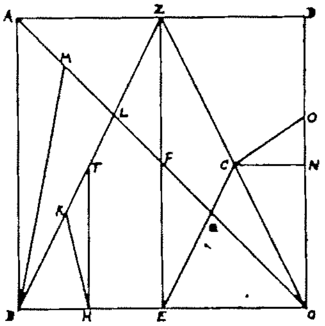


FIG. 1.

These doubts have been largely cleared up by the discovery, in 1906, by Prof. J. L. Heiberg, of Copenhagen, that a palimpsest, preserved in Constantinople, was overwritten on a copy of the works of Archimedes, which has not only yielded very important additions to the previously known body of his writings, but also contains, at the end, part of a book of the Stomachion, the existence of which had been unknown. This fragment was first published in 1913, in the second edition of the works of Archimedes, edited by Prof. Heiberg for the Teubner Classical Library (vol. 2, p. 416 ff.). The opening paragraph of this fragment says that as the thing called the Stomachion presents examples of the method of transposition of figures, he thinks it well to treat of these and to show how it is divided and how the parts resemble each other, so that, in forming them into pictures, one may see how the angles may be combined to form two right angles, and whether two sides, which appear to lie in a straight line, do so, or depart slightly from it; though a picture is not necessarily to be rejected on account of a small gap resulting from this. It is evident from this summary that the complete book would have made a very interesting treatise on the game, but only two short passages remain. The first, following immediately on the introduction, demonstrates that the angle AMB (Fig. 2) must be an obtuse one, and the second, following on a gap, is part of the description of a construction, similar, so far as it goes, to that

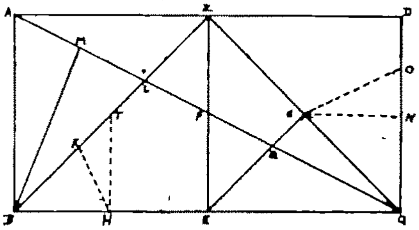


FIG. 2.

described in the Arabic manuscript, with the instructive addition that, after the first division of the whole figure into two equal halves, each half is a square.

From these passages two conclusions may be drawn: that the pastime was really an invention of Archimedes, and not merely fathered on him, and that the initial figure of the loculus was not a square, but a rectangle composed of two squares, set side by side. This makes it possible to reconstruct the pattern of the divisions, as shown in Fig. 2, where the firm lines show the construction, so far as the text of the palimpsest goes, and the dotted lines the completion, taken from the Arabic text. I have, however, made one departure from the Arabic, in drawing the triangle OCN, which appears necessary if the thing is to be used in the manner described, and not as a mere exercise in geometry.

If Fig. 2 is examined it will be seen that the angles are either right angles, or the angles made by the diagonal of a square, or those made by the diagonal of a rectangle twice as long as it is broad, or the sum or difference of some two of these, so that there are many possible combinations by which either two or four right angles can be built up. Also, for length of side, we have the whole, half or quarter of AB, the half, third or sixth of BZ, and the third or sixth of AG, so that there are a number of sides which can be matched with each other, either singly or in combination. To this there are two exceptions: the line BM cannot be matched with any other side or combination of sides, nor can the angles at B and M be matched with any others to complete either two or four right angles, but the other sides of the two triangles, based on this line, and the angle between them can readily be matched, as can the combined triangle ABL. The other exception is the triangle OCN, and this is a very different case; if drawn according to the Arabic construction, with CO as a continuation of BC, it would have the angles of the diagonal of a rectangle of sides three by one, and the common side CO, the two sides NO, OD, and the four angles at O and C would none of them be matched with any other sides or angles. If, however, DN is bisected in O, we have a construction more in tenor with the rest, and get a triangle with angles of the diagonal of a two by one rectangle, though the length of the side CO, being one quarter of AG, would still be impossible to match with any other side. For these reasons it seems probable that, whatever may have been the original construction, designed as an exercise in geometry, the modification would soon have been introduced when it was adopted as a pastime, for, so far as may be judged from a slight experience, it is a marked improvement.

However this may be, it seems clear that, with this possible, though not probable, exception, we have, in Fig. 2, the actual pattern of the pieces forming the loculus mentioned in Latin literature. As examples of what can be done with it I may give a few ridiculous efforts of a novice (Fig. 3); the elephant (i), the ship (ii) and the two figure studies, which I owe to Sir Richard Paget, of the Pied Piper (iii) and the Pundit (iv) will give some indication of the wide range of subjects which can be depicted, in a somewhat cubist style it is true. The last-named figure, it may be noticed, contains one of those small gaps, which, the palimpsest expressly declares, need not involve the rejection of the figure. In each case the whole fourteen pieces are employed, this being, presumably, of the essence of the game; it happens at times that a satisfactory figure may be built up, with one or two pieces to spare, and then the fitting in of these superfluous pieces becomes the thing that drives one wild.

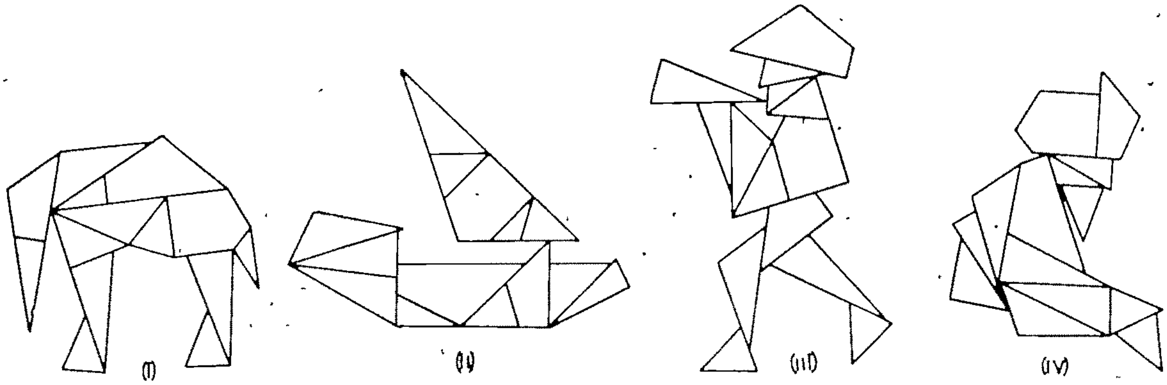


FIG. 3.

R. D. OLDHAM.

Use of an Artificial Horizon in Photographic Measurements of Buildings or other Structures.

IT is sometimes required to know whether certain lines intended to be vertical or horizontal in buildings or other structures are really so, and if not, by how much they deviate from these directions. All such measures can, of course, be made by a theodolite or level, but when many details have to be examined this is a long process.

A photographic method, however, which I made use of during the construction of the Tower Bridge, and elsewhere, compresses in a few negatives information which it would take weeks to acquire by direct instrumental observation on the spot.

This method, which I have had occasion to use again recently, consists in photographing the object to be measured, together with its image in an artificial horizon. If the lens used is free from spherical aberration and the plates are suitable, each negative will yield all the information which could be obtained from a theodolite of the same focal length.

Collodion plates give the best results. In all gelatine emulsion plates the coarseness of the grain is against the use of high power in the analysis of the image, and the more sensitive the plate the coarser the grain.

If a_1 a_2, etc., are points in the direct image and a'_1 a'_2, etc., corresponding points in the reflection, then straight lines joining a_1 a'_1, a_2 a'_2 are true verticals, and the straight line through their bisections is a true level, and indicates the line in which the plane of the artificial horizon cuts the object photographed.

Measurements made on the plate, therefore, will indicate how much out of 'plumb' any line may be, and also the angular altitudes of any points (above the plane of the artificial horizon) as well as their azimuths. Photographs of this kind might in many cases be substituted with advantage for plane-table work.

The only adjustment which must be made with any degree of accuracy is the levelling of the camera, that is, ensuring the verticality of the photographic plate. If the plate makes an angle α with the vertical, the images of true vertical lines will converge to a point on the plan of the plate distant from the centre by a quantity proportional to cot α, and the image of a line joining the direct and reflected image of a point the azimuth of which is β and altitude γ makes an angle $\tan \alpha \tan \beta \tan \gamma$ with the true vertical. If α is small (a quarter of a degree or less) the error introduced is for most purposes negligible.

It is unnecessary to describe in detail the reduction of the measurements taken from the negatives, but a few notes on the general result may be of interest at the present time when there seems to be a widely spread notion that modern forms of traffic have an injurious effect on adjacent buildings.

Those who are acquainted with the subject do not require to be reminded that such disturbance of the ground as is caused by traffic has no effect on the stability of buildings, but the belief to the contrary is still common, and cracks and subsidences due to very different agencies are often imputed to 'vibration.'

Such experience as I have had leads me to believe that it is rare to find any building, whether old or new, in which lines intended to be vertical are not measurably out of 'plumb.' In what may be called domestic architecture—cottages and small houses—the errors sometimes approach 1°. For large buildings and factory chimneys, which have presumably been built under some sort of supervision, the inclinations to the vertical are much smaller, often only a few minutes of arc. In mining districts (in which I have not yet had any experience) the effects of subsidence would probably give much larger angles.

In the few old churches to which the method has been applied, I have not found more than 10′ or 12′ deviation from the perpendicular in the towers. For the interior columns, however, this is sometimes exceeded.

Referring to a few particular buildings, I could find no error in the verticality of the western towers of Westminster Abbey or in the Clock Tower of the Houses of Parliament.

The top of Salisbury spire is about 13 inches to the south of the position it should occupy, and the columns which carry its weight have been bent inwards by the thrust of the vaulting of the aisles. Their maximum horizontal displacement is only about 4 inches, but the effect as seen from the west end of the nave is conspicuous. There is, so far as I know, no evidence as to whether the bending took place at the time of the completion of the spire, or later. Something of the same kind happened at Wells, and the inverted arches in that cathedral were introduced as a safeguard.

It is not uncommon to find that foundations have sunk locally as the load placed on them increased, and that building on the sunk foundation has been continued in a more or less true vertical direction, thus introducing a 'kink' in what should have been a straight line. The east end of the church in Smith Square, Westminster, is a good example of this. In St. Paul's Cathedral also there is similar evidence of a local sinkage of foundation during construction, but this cannot be seen from any ordinary point of view.

It would be worth while to obtain, for future reference, a regular series of artificial-horizon photographs of the principal existing buildings both at home and abroad, and these would be particularly interesting for earthquake and mining countries and also for towns built on pile foundations.

I expect it would be found that where buildings have remained unchanged for a few years after completion they would remain unchanged for centuries, provided that the conditions of the ground about the foundations were not interfered with as regards drainage and distribution of pressure, and that where subsidence occurs it is in these directions that the cause should be looked for.

A. MALLOCK.

9 Baring Crescent,
Exeter, January 16.

Acidity of the Medium and Root Production in Coleus.

IN order to test the effect which the reaction of the medium has upon root-production by cuttings, experiments have been made during the summers of 1924 and 1925 with Coleus. It is the practice at the Royal Botanic Garden, Edinburgh, to root in cocoa-nut fibre cuttings which require heat. It was found that the fibre gave a reaction of pH 4·5-4·7, and was very strongly buffered, large additions of acid or alkali being necessary to shift the pH appreciably. (The testing was done with the B.D.H. Capillator, the brown colour of the water squeezed from the fibre causing little trouble in the capillary tube.) In view of this marked buffer action, it is not possible to use this natural fibre for experiment, though it is excellent in practice, being of a light texture and holding a good amount of water without becoming sodden. An artificial medium, comparable to the natural fibre in physical state, of which the reaction can be controlled, has yet to be found. Sand, cotton-wool, and glass-wool, with water, and water alone were tried; only the last proved satisfactory. Experiments were accordingly made with tap-water, adjusted to the required pH by the addition of traces of hydrochloric or sulphuric acids or of sodium carbonate, the normal pH of the water being about 7·3. While these results cannot be directly transferred to the case of fibre, owing to the great differences in oxygen supply, they are at least suggestive.

The cuttings were made at random from plants of a form of *Coleus Blumei*. They were placed in large, carefully cleaned gas-jars, with about two inches of water. The water was changed as often as the indicator showed a marked departure from the initial *p*H—at least once in 24 hours. (All the solutions became more acid, owing to respiratory carbon dioxide: this was proved to be the chief source of acidity by the ease with which a current of carbon dioxide-free air restored the initial *p*H. The following indicators were used: thymol blue, phenol red, brom-phenol blue, di-ethyl red, methyl orange, brom-cresol green. At the dilutions used they were not toxic to the plant in seven days.) The cuttings were thus fully turgid, and no time was lost through preliminary flagging. At the end of the experiment (after seven or fourteen days) the roots of each batch were cut off, and roots and cuttings weighed separately after being dried to constant weight at 100° C. The weight of root corresponding to 1 gram of cutting was taken for comparison.

It was found that rooting would only take place between *p*H 4·0 and *p*H 9·2. Below *p*H 4·0 the ends in contact with the water quickly became soft and died. Within these limits *p*H 7·0–7·2 was the most favourable for root production; and *p*H 4·5 was more favourable than *p*H 9·2. The results for one experiment were:

*p*H 4·5 : 1 gm. cutting corresponds to 0·05540 gm. root.
*p*H 7·2 : 1 ,, ,, ,, 0·08138 ,,
*p*H 9·2 : 1 ,, ,, ,, 0·04318 ,,

Even without weighing, the batch at about *p*H 7·0 was easily seen to be ahead: the roots appeared from one to three days earlier and were usually longer than the others.

The condition of the carbohydrate reserves had a marked influence on the rooting. Two lots of the same form of Coleus were used, one growing in full light and the other in a shaded house. The first had brightly coloured leaves and short red internodes, and the reserves were largely starch, with traces of reducing sugars. The second plant had larger and paler leaves, and longer internodes with no red colour, and the chief reserve was reducing sugar. The 'starch' plants produced more roots and produced them more quickly than the 'sugar' plants, regardless of the reaction of the medium. In all cases there was a basipetal concentration of reserves in the cutting after a few days.

The *p*H values of the tissues of the stem were examined by placing thick sections of fresh material (first washed in neutral water) in dilute solutions of di-ethyl red, methyl red, brom-cresol green, brom-cresol purple. They were found to be as follows: pith 5·2, xylem 4·4, cambium 5·8–6·0, phloem parenchyma, 5·8–6·2, cortex 5·2.

In fibre the cut end of the stem shows an intense reaction with Sudan III., indicating that the cut cells are blocked with fatty substances, and a basal meristem forms callus to a depth of three or four cells. In water the cut end stains only slightly or not at all with Sudan III., and callus formation is inhibited, but in spite of this rooting goes on freely.

These results indicate that the free admission of air is one of the most favourable aspects of the fibre, and suggest that (for this plant at least), given equal supplies of oxygen, a reaction of the medium near neutrality would be preferable.

These experiments are being continued on quantitative lines, in the hope of ascertaining more exactly the optimum reaction of the medium for this plant.

E. PHILIP SMITH.

Laboratory of Plant Physiology,
Royal Botanic Garden,
Edinburgh.

Genes and Linkage Groups in Genetics.

IN making a final reply to Prof. Huxley on the subject of linkage and genes, I should like to say that I resent very strongly his accusation that I refuse to keep to the point which he has raised. I may remind Prof. Huxley that he began the discussion by attacking my review in NATURE of Haecker's "Pluripotenz"; that he asked me for my views on the nature of linkage groups and unit-factors; and that when I answered him as briefly and clearly as possible, he replied by giving a lengthy exposition of the well-known 'results' of the Morgan school of Mendelians.

Prof. Huxley knows perfectly well that I could not deal with such an exposition without examining critically the evidence on which the 'ratios' were based, the value of the mathematical formulæ, and above all, the criteria for discriminating unit-factors, and that to accomplish all these things would be altogether impossible within the ambit of a letter to NATURE. All I could do was to indicate my general scepticism as to the value and soundness of Morgan's methods and to attempt to give my reasons for regarding the whole method of 'factorial analysis' as a futile way of attempting to solve the problems of heredity and mutation. Of course, I never denied that segregation of paternal and maternal characters occurs when a 'mutant' is crossed with the type, and in the "glad confident morning" of Mendelism twenty years ago, it appeared as if it would be an easy task to analyse this segregation into 'factors.' The attempts at this analysis, continued during the present somewhat overclouded afternoon of the theory, have led to such absurd and impossible results that they have induced many besides myself to regard the whole analysis as radically unsound in principle.

By a singular coincidence I have just received from Prof. R. Woltereck a copy of a paper which he has written on the gene for the 'eyeless' mutation in Drosophila (Zur neuen Genetik: II. Einiges über die Augenmutanten von Drosophila und besonders über die Mutation "eyeless," *Die Erde*, vol. 3, Heft 9, 1925). In this paper Prof. Woltereck examines all the work that has been done on this so-called gene. He points out what enormous individual variations are classed together under the head of the single 'unit-factor'; he states that to endeavour to account for these variations by introducing additional unit-factors only obscures the question by bringing in further 'unknowns' into the problem; and he concludes by observing that the only satisfactory way of dealing with the problem is a physiological one, which he enunciates in language almost identical with my own. He says that there is a normal grade of developmental energy in every animal which expresses itself in the typical development of every organ (thus the ommatidia of the Drosophila eye increase to a certain number and then stop); that in the eyeless mutants this energy encounters an increased amount of resistance varying in amount from individual to individual, due to the condition of the 'internal environment.' I should have preferred to say that the developmental energy had suffered different degrees of weakening, but that is a minor point.

As Prof. Huxley still seems to be in doubt as to my meaning, let me state again that I regard a linkage group as caused by a definite form of constitutional weakness, or as I should term it germ-weakness, the linked genes being "outward and visible signs" of this weakness. A good example of a definite type of germ-weakness is afforded by amniotic pressure in the developing vertebrate. This, differing from case to case in its intensity, duration and period of onset, can manifest itself in the most varied groups of 'factors' showing different degrees of 'linkage.' Prof. Huxley says that he does not know what I mean by calling a unit-factor a 'change.' A unit-factor can only be defined and has always been defined by *its deviation from the type*: that is what I meant by calling it a change.

Prof. Huxley refers to the attempts of Stresemann to account for specific differences between birds on the basis of supposititious mendelising mutations. Stresemann is not the only Mendelian who has attempted this futile task: no good systematist known to me will have anything to say to it, and if readers of NATURE wish to convince themselves of the utter bankruptcy of all such efforts, I recommend them to read the latest and most elaborate of them by Goldschmidt ("Untersuchungen zur Genetik der geographischen Variation," *Arch. f. mikr. Anat. u. Entw.-Mech.*, vol. 101, 1924), in which he deals with the geographical races of *Lymantria dispar*. After trying in vain to account for his results by assuming (*pace* Prof. Huxley) Mendelian factors, he is driven back to the assumption of maternal and paternal (!) cytoplasmic influences, and even then does not arrive at a satisfactory solution. He thinks it could perhaps be done by assuming 'modifying factors' (Morgan's patent), but deems such a procedure beneath his dignity. Really, when Prof. Huxley says that Mendelian factors are not 'assumed' one doubts if he realises the meaning of words.

The central fact of biology is adaptation: its central problem is the origin of this adaptation, and until Prof. Huxley recognises this he will continue to flounder in a quagmire of imaginary 'factors,' the number of which will require continual augmentation, as Nature exhibits herself more and more unwilling to be comprised within the narrow formulæ of the geneticists Really, the top-heavy structure already evolved in the imagination of these gentlemen reminds us of nothing so much as the Ptolemaic conception of the heavens "with cycle and epicycle scribbled o'er," which preceded the views of Kepler and Galileo. E. W. MACBRIDE.

Imperial College of Science and Technology,
South Kensington, London, S.W.7.

THE purpose of my letter published in NATURE of January 16, p. 86, was to support, by an example, Prof. MacBride's view that mutations that appear together have some common developmental cause. From Prof. Huxley's letter it seems that the term 'linkage-group' is to be used only if this cause be unknown, when the hypothesis that the characters are associated because their factors are in the same chromosome is less easily disproved.

C. TATE REGAN.

The Palæolithic Drawing of a Horse from Sherborne, Dorset.

IN NATURE of February 13, p. 233, Mr. C. J. Bayzand describes how his leg was pulled by certain boys of Sherborne School (for whose conduct, on their behalf, I wish to apologise to him) with respect to the finding of this inscribed bone.

As I probably know most about the circumstances of the find, I may be allowed to state the facts.

In, if I remember rightly, September 1911, among the new boys who visited the school museum for the first time were A. Cortesi and P. C. Grove, who asked where they could obtain fossils like those in the museum. I directed them to a certain quarry where, as it was being worked, they could find ammonites, etc. In this quarry, on a heap of broken stone, which the workmen told me had come from the opening to an adjacent fissure, still visible, where the rock was much broken, Cortesi, in the presence of Grove (who died in the War), picked up, among other things, a bone, which he handed to the latter, asking if it was a fossil. Grove said "No"; but in giving it back he noticed a drawing upon it. So Cortesi took it to his boarding-house, where in the evening it was examined and thought little of; but when Cortesi was about to throw it into the fire he was stopped by Jefferson (then a boy who had been a year in the school), as stated by him in a recent letter to the headmaster, which I am permitted to send for publication. The bone was accordingly brought to me for inspection, and afterwards given to the school museum by Cortesi.

That two new boys should have made such a discovery was, as any public school boy will understand, not looked upon favourably by many of the older boys, and very soon sides had been taken, for and against, and as "fama viret eundo," the latter party soon changed the locality of the find to a town refuse heap, and would-be recruits were shown how Cortesi must have drawn it, though this was not very effective, for he could not draw "for nuts," as boys say, and the Town Council of Sherborne burned their refuse and do not allow inhabitants to keep horse bones on their premises till they are as brittle as this one.

Eighteen months *later* the quarrymen broke into a narrow cave forming the lower part of the same fissure, and it was then evident that the heap on which the bone was found was composed of the debris from the quarrying away, some years before, of the entrance to this cave, which pointing south-west was situated near the summit of a short narrow valley, now dry from the working back of some of the Somerset streams draining the low land between Sherborne and Glastonbury and the Mendips, and in which, lower down, we have discovered remains of the mammoth and woolly rhinoceros.

Cortesi was always very jealous for his find to be attributed to himself alone, so it is improbable that any one else at Sherborne drew it, and he certainly could not himself. As a hoax on a master, a new boy in a public school, with all his troubles before him and without for some years any privacy, would scarcely think of hoaxing masters he knew nothing about, in fact, Cortesi's letter to the headmaster disposes of anything of that kind.

I have done my best to unravel the mystery of its production, if it is a 'fake,' and I have come to the conclusion, which I hope Prof. Sollas will accept, that it was not manufactured at Sherborne School. Like Mr. Bayzand, I always felt its similarity to Sir W. Boyd Dawkins' Creswell Crag specimen must raise doubts; but since I, as in duty bound, submitted it to the inspection of the members of the Geological Society, my doubts have been somewhat allayed and I have placed my trust and confidence in them, seeing that I am not in a position to be able to express an opinion myself May I therefore, in conclusion, ask some member of that learned society to explain how they got over this difficulty of similarity to the Creswell Crag inscribed bone? R. ELLIOT STEEL

Stalbridge, Dorset,
February 18.

Copy of Part of the Letter of Mr. E. A. Ross Jefferson.

17 Kensington Palace Mansions,
De Vere Gardens, W.8,
12.2.26.

DEAR HEADMASTER—Perhaps I may be able to throw some light on the "Palæolithic Bone." Cortesi showed it to me when he was about to throw it in the day-room fire, and I told him not to be such an Ass; as I had been reading about the Palæolithic Period, and saw at once that the bone was a real find.

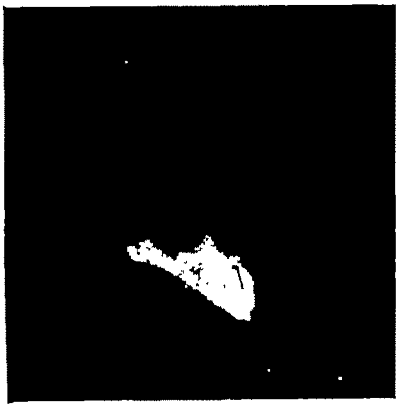
I told him to show it to Bob Steel, which he did; and for that reason it is in the museum to-day.

. . . .

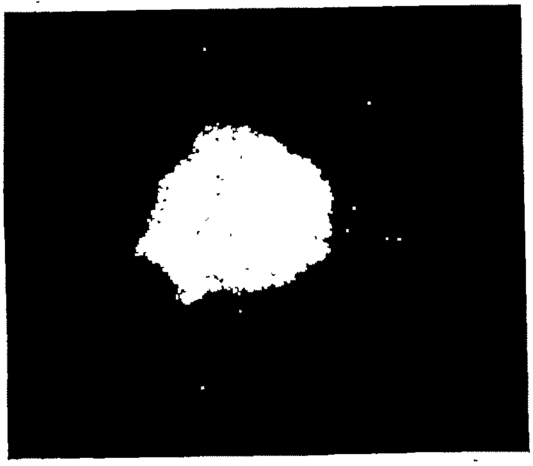
The idea of the bone not being genuine was a rumour started by that arch-humourist, Mr. X.—Yours sincerely, E. A. ROSS JEFFERSON.

A Single Electrode Arc.

THE accompanying photographs (Fig. 1) represent a somewhat extraordinary manifestation—a single electrode arc. The discharge is produced by the application of alternating voltage of the order of 5 kv. at frequencies higher than about 10,000,000 cycles to an electrode consisting of a short length of wire. It may occur spontaneously if the wire is sufficiently thin (0·1 millimetre), with a thicker electrode it must be started by touching the end of the wire with a glass rod, which is then withdrawn. The discharge has the appearance of a flame or arc having one or more tongues up to 15 centimetres long and is coloured faintly by the electrode material.



(a) Copper



(b) Molybdenum

FIG. 1.

If the arc is drawn from the end of the wire it forms a globule of molten metal from which it burns until the temperature of adjacent portions of the wire and/or the diameter of the globule indicate that it should move elsewhere This movement has just taken place in the photograph (Fig 1 (a), copper electrode) in which the molten globule can be seen. In general the movement of the flame is controlled by the melting of the wire. Under the conditions of the experiment the arc consumed about half a kilowatt.

Presumably the production of the arc depends on the frequency being so high that ions of one sign are not wholly collected by the electrode during one half cycle, and that de-ionisation is small during the period when the potential is changing sign.

N. RYLAND DAVIS.
C. R. BURCH.

Research Laboratories,
Metropolitan-Vickers Electrical Company, Ltd.,
Trafford Park, Manchester, January 23.

The Herrings of the Eastern Part of the English Channel.

DURING the great East Anglian herring fishery which takes place during October, November, and part of December, almost all of the fish taken are either spawning or are in the condition which just precedes spawning.

It has been shown that the main areas in which eggs are deposited are near Smith's Knoll L.V., near the Gabbard L.V., and also in the neighbourhood of the Sandettie L.V, and, with the exception of the latter place, that the spawning fish are in the minority. This must mean, then, that there is some other area in which spawning takes place.

In 1923 and 1924 an attempt was made to locate these fish after their disappearance from the Southern Bight in December. Herrings were obtained from Brighton in the winter of 1923–4, and from Swanage in 1924–5, but, on examination, it was shown that they were of a very different type from those of the southern North Sea. These fish, according to the maturity observations, belonged to a shoal which spawned in December-January, but the nature of their annual growth as shown by their scales proved without doubt that they were not fish which had migrated from the North Sea.

In the paper recently published by the Ministry of Agriculture and Fisheries, I have pointed out that there are two groups of herrings in the southern North Sea, and these are classified according to their first year's growth as calculated from the first winter ring on their scales. One group was found to be approximately 8 cm. at the end of its first year, and the second 10 cm. This difference is probably due mainly to the difference in the time of year in which they were spawned.

The fish from the English coast of the Channel were found to be approximately 12 cm. at the end of their first year, and, age for age, were larger than those of the North Sea. The fact that these fish were found in two successive years along the southern English coast made it appear at first very doubtful that the remainder of the East Anglian herrings migrated into the Channel to complete the spawning. It was known that there was a fishery along the French coast during December and January, and also that after this period it was possible with suitable gear to obtain larval herrings in the neighbourhood of Cap d'Antifer; so with this information an investigation was carried out at Boulogne in January this year, with the view of establishing the identity of these herrings.

Below I give an outline of the results obtained.

Fish which were actually spawning, and also some which were newly spent, were obtained, and an examination of their scales was made. Here is the age composition of one of the samples of spawning fish :

Age (years) . .	3	4	5	6	7	8	9	10	
No.	20	64	17	32	8	—	—	3.	Total 144

There are, it will be seen, two main groups, the four-year-olds and the six-year-olds. From the scales of the '4' group I have calculated the length of the fish to the end of each year of their life, and the averages of l_1, l_2, l_3 are found to be 8·55, 16·42, and 20·88 cm. respectively, which, according to the work already published, classes them as southern North Sea herrings.

The peak at '6' is of different composition. Here, without calculation, it is possible to detect two different kinds of growth in the scales—the large Channel type of l_1, and the smaller southern North Sea type—so it is safe to say that while North Sea fish are found spawning along the French coast in winter, there are also Channel fish in the shoal which are spawning at the same time.

W. C. HODGSON.

Fisheries Laboratory,
Lowestoft,
February 2.

Domestic Heating.

I FULLY agree with Mr. Gheury de Bray in the letter on this subject in NATURE of February 6: open fires in a house are immeasurably preferable to electric or gas fires.

For some time past I have studied not only the microscopic structure of coal, but also its vital effects, and I am absolutely convinced, and desire clearly to enunciate, that it is sociologically most important as well as scientifically interesting that the valuable vital effects of a glowing coal fire should be realised. A glowing coal fire gives out something subtle, yet intensely 'nourishing' to the system, 'nourishing' in a way that vitamins and ultra-violet rays are 'nourishing.' Whatever this stimulating influence may be, it is either absent or very weak in radiation from anthracite stoves or gas and electric fires. Hence, for health, a brightly glowing coal fire should be present in every nursery, and in the chief living-room in every house.

Further than this, the curative powers of such a fire are great. An illustration may emphasise this. After a very severe illness, when I had been at death's door, and still suffered with a high temperature and intense weakness, I insisted, to the horrified amazement of the hospital nursing sisters in charge of me, on being lifted from my bed and, protected by screens from draughts, lying naked before a specially prepared brightly glowing coal fire for half an hour. So rapid were the beneficial effects, that in fifteen or twenty minutes even the nurse in charge recognised them as indicated by the steadying and rate of the pulse, the temperature, and a marked improvement in the feel and appearance of the skin, to say nothing of the sense of returning health and increased vitality to which the patient alone could testify. The regular use of the coal fire in this way greatly contributed to my rapid recovery and returned vitality. When overtired or threatened with a cold in the head, whenever possible, I use the same measure, always with beneficial results. This is not due simply to the airing of the skin (most valuable also in its way), as the effect does not result from stripping in a room equally warmed by plated hot pipes and electricity.

At present, when so many homes are being built regardless of the value of the coal fire, or with improperly constructed coal fires, it is important that the plain common-sense man and woman should not allow their common sense to be crushed out of them by pseudo-science which professes that the substitutes offered by gas or electricity are equally effective. The question of fires seems to me at present to be parallel to that of the 'scientific' provision of substitutes like margarine for butter some years ago, when farm women and servants were laughed at by scientists for preferring real butter to margarine, and have since been proved by profounder scientists to be quite right, butter containing vitamins absent in margarine.

What the 'nourishing' substance in a brightly glowing coal fire is, I do not yet know, but it will be found out some day. There are many extraordinarily interesting and subtle points about the composition of coal which are not yet fully investigated. For example, the vitrain bands in an ordinary banded bituminous house coal affect a photographic plate in the dark so as to imprint themselves as a clear image upon it (see Stopes, *Phil. Trans. Roy. Soc.*, 1919, p. 470).

Our race is being weakened by innumerable interferences with our natural physiological processes, and therefore, in the interests of the race, of the health and happiness of the individual, as well as in the name of science, may I emphasise the immense importance of not flouting the natural instinct of the British people to use bright *coal fires*.

MARIE C. STOPES.

Givons Grove,
Leatherhead, Surrey,
February 15.

Conservation of Momentum and the Doppler Principle.

SINCE on the relativity theory mass and energy are related by the equation $Mc^2 = W$, the different energy states of an atom may be thought of as being different mass states of the atom. For example, on the quantum theory when an atom changes from an energy state W_p to an energy state W_q, a quantum $h\nu$ is radiated such that $h\nu = W_p - W_q$ (W_p being supposed greater than W_q), and hence $h\nu$ may be supposed to be produced by a loss of mass in the atom as a whole. We shall therefore consider an atom to have a mass M_p before the emission of a quantum $h\nu$ and a mass M_q after the emission. Each of these masses consists of the rest masses of the various parts of the atom together with the mass due to the kinetic and potential energies of the various parts. Further, although parts of the atom may be moving relatively to each other, we shall suppose that M_p and M_q are the rest masses of the atom as a whole in the two states.

Let us now consider the case where an atom of rest mass M_p is travelling in the direction θ with respect to the OX axis with velocity $\beta_p c$. At a certain instant of time the mass M_p changes to mass M_q and a quantum $h\nu$ is emitted in the OX direction, the atom of rest mass M_q then moving with a velocity $\beta_q c$ in the direction ϕ. The principle of conservation of energy requires

$$\frac{M_p c^2}{\sqrt{1 - \beta_p^2}} = h\nu + \frac{M_q c^2}{\sqrt{1 - \beta_q^2}}, \quad . \quad . \quad (1)$$

while the principle of conservation of momentum requires

$$\frac{M_1\beta_1 c\cos\theta}{\sqrt{1-\beta_1^2}}=\frac{h\nu}{c}+\frac{M_2\beta_2 c\cos\phi}{\sqrt{1-\beta_2^2}}, \quad . \quad . \quad (2)$$

and

$$\frac{M_1\beta_1 c\sin\theta}{\sqrt{1-\beta_1^2}}=\frac{M_2\beta_2 c\sin\phi}{\sqrt{1-\beta_2^2}}. \quad . \quad . \quad (3)$$

Solving for $h\nu$ we find

$$h\nu=\frac{(M_1^2-M_2^2)c^2}{2M_1}\cdot\frac{\sqrt{1-\beta_1^2}}{1-\beta_1\cos\theta}. \quad . \quad . \quad (4)$$

Now, if $\beta_1 c$, the velocity of the atom before the emission of the quantum, is zero, then the quantum emitted is $h\nu_0$, where

$$h\nu_0=(M_1^2-M_2^2)c^2/2M_1, \quad . \quad . \quad (5)$$

so that equation (4) may be written

$$\nu=\nu_0\sqrt{1-\beta_1^2}/(1-\beta_1\cos\theta). \quad . \quad . \quad (6)$$

If β_1 is small, then writing $\beta_1=v/c$ we have

$$\nu=\nu_0\times c/(c-v\cos\theta), \quad . \quad . \quad (7)$$

the formula for the Doppler principle. It seems therefore that the Doppler principle may be deduced without recourse to a wave theory.

If $\beta_1=0$, we may solve for the velocity of recoil $\beta_2 c$ and find

$$\beta_2 c=c(M_1^2-M_2^2)/(M_1^2+M_2^2)$$
$$=2M_1h\nu_0/(M_1^2+M_2^2)c. \quad (8)$$

For light of about 4000 Å.U. emitted by the hydrogen atom:

$\beta_2 c=100$ cm./sec., while $(M_1-M_2)=5\times10^{-33}$ gm.

G. E. M. JAUNCEY.

Washington University,
St. Louis, U.S.A.,
January 22.

An Australian Fossil Jelly-fish.

QUITE recently a remarkable discovery of a fossil jelly-fish has been made in the fine-grained blue mudstone of the lower part of the Silurian at Brunswick, Victoria. It was in the same locality, but at a higher horizon, that another unique discovery was made about twenty-four years ago, of an exquisitely preserved crinoid, *Helicocrinus plumosus*, of which the entire organism was found, including the coiled distal end of the column.

The present fossil occurrence is unique for Australia, so far as I am aware, and the only other related form is a Discophyllum (*D. peltatum*) figured and described by James Hall in 1847, from the Hudson River Series, below Troy, New York.

It is especially noteworthy that our basal Melbournian stage of the Silurian comes, in point of geological time, immediately after the American sediments, so that these two widely separated occurrences practically agree both in morphological affinity and in age.

The Victorian Silurian jelly-fish is shown in strong relief on the two halves of a slab. The umbrella is radiately ribbed and concentrically frilled. The genital pockets are distinct and there is a zone of comparatively short tentacles more or less clearly marked.

Notwithstanding the paucity of definitely preserved skeletons of invertebrates, such as mollusca and arthropods, in the Victorian mudstone, very much original structure has been retained in fossils that would not, in the ordinary way, be regarded as good museum specimens. From similar fine-grained mudstones in Victoria, the soft gill-plumes of the Serpula-like Trachyderma have already been described, in which even the eyes are still visible as carbonised spots. There is little doubt that a careful and prolonged search amongst these supposed unfossiliferous mudstones would result in many thrilling discoveries, and it is fortunate that the above fossil fell into the hands of so careful a collector as its discoverer, Mr. R. Evans.

FREDK. CHAPMAN.

National Museum, Melbourne,
January 12.

Measurement of Radiation Intensities by Photographic Methods.

DR. HOUSTOUN, referring in NATURE of January 30, p. 159, to Dr. Toy's note on the above, deprecates the use of 'neutral' absorbing screens, and recommends that the intensity of a beam of radiation be reduced by increasing the distance between source and screen and applying the inverse-square law. In view of the simplicity of action and ease of calibration of neutral screens or wedges, it is surprising that at this stage in the development of photometry, a method possessing so many disadvantages as that suggested by Dr. Houstoun should be seriously considered. If large variations in the intensity of radiation are required, say of the order of 2000 to 1, any instrument depending on the direct application of the inverse-square law must necessarily be extremely cumbrous. Further, the effect of reflected radiation from adjacent surfaces is difficult to eliminate, and the necessary correction for the absorption of the intervening medium detracts from the apparent simplicity of the method.

The 'neutral' wedge, on the other hand, provides an accurate and compact means of altering the radiation intensity throughout a very wide range. Wedges can be obtained which are practically neutral over a large portion of the visible spectrum. Even if the absorption varies with wave-length, as it does, for example, in the ultra-violet, the wedge is easily calibrated in its actual position in the apparatus, so that its lack of neutrality is not really detrimental to its use. Again, the wedge produces a continuous change of intensity, whereas any method depending upon the inverse-square law can in practice only change the intensity by finite amounts. Optical wedges have been used here in many different types of researches and have proved both convenient and accurate.

I. O. GRIFFITH.

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What is a Beam of Light?

PROF. GILBERT LEWIS'S views (NATURE, February 13, p. 236) stretch far, but will he, or any one else, begin at the first stage?

As any group of incandescent atoms must be at every variety of phase of distance, why does any beam of light behave as if it all started from an identic single phase? How can interference appear if two streams of waves moving at every phase interact? There cannot be lamination of space at a wave-length apart, as wave-lengths are varied, and incandescence is the same in all directions.

Another difficulty; in a bundle of waves vibrating in all azimuths, how does polarisation separate the whole light into two parts vibrating at right angles? A selective action might only transmit waves nearly in the same plane, but polarising appears to take all light up to 45° from its plane. Is every separate vibration, or quantum, or corpuscle split into two components?

To the outer layman it looks as if the clearing of these fundamental questions would be a useful preliminary to further theories.

F. P.

The Species Problem and Evolution.

By O. W. RICHARDS and G. C. ROBSON.

I.

THE object of these articles is to describe and discuss some of the chief attributes of closely allied species in so far as they may cast some light on the process of evolution. The method by which the latter has been brought about is still a matter for discussion, and one of the chief lines of inquiry to which great importance is attached to-day is the intensive study of the early stages of specific divergence. Darwin and the biologists of last century did not, of course, neglect this question; but within the last twenty-five years much has been discovered concerning animal ecology, genetics, and the intensive study of distribution, so that a review of the evolutionary position from these points of view may be of service. The problem will be here discussed principally from the zoological point of view; but some attempt will be made to indicate to what extent the method of evolution in plants is likely to differ from that in animals.

In the course of this discussion it will be seen that no absolute criterion of species can be given. Such distinctions have been sought in structural differences or in some special type of sterility. With regard to the latter criterion, sterility between many forms is well known, but it is uncertain whether there is a special type which can be called specific. Structural discontinuity has been supposed to be a good criterion of species; but the number of characters in which such discontinuity may occur and the degree of discontinuity itself are variable.

In any genus, when the taxonomically described species are compared one with another, it is found that the latter differ in a variable number of structural characters and that no fixed amount can be proposed by which they must differ in order to be called species rather than varieties. Structural discontinuity between such species is sometimes very evident within the limits of a single area; but it frequently becomes much less marked when a complete range of such forms is investigated. In the majority of cases specific distinction is based on the examination of a few characters only which are selected for convenience, and, as a result, the actual amount of difference between species is often doubtful in a particular case. However, in spite of the lack of an absolute criterion, the majority of forms recognised as species by taxonomists represent within broad limits a certain grade of divergence in structure and habit, and are frequently sterile, when crossed.

Some palæontologists have shown that certain forms occurring in successive strata are continuously connected by 'intermediates,' and have thought that the species concept, as it is employed by zoologists, is inapplicable to series of forms in which only the lineage of single characters can be traced. In the first case our knowledge of the relationship of different specimens must be confused by the effects of the environmental conditions which they have experienced; while the second phenomenon has not been shown to be widely spread, and in many groups species may remain well defined over long periods of time.

SPECIFIC CHARACTERS.

Specific differentiation may show itself in several ways, namely, in (1) structure, (2) physiological activities, (3) reproduction, (4) habitat-preference, (5) food, (6) special types of behaviour. When species differ in habits or structure it is probable that they differ physiologically as well, though it is difficult to show a correlation between such differences and any particular physiological process. The result is, therefore, that in practice species are distinguished by differences in their habits and structure because it is not yet possible to do so by reference to their more fundamental properties. The term physiological difference is here used in the narrow sense of difference in metabolism.

1. STRUCTURE. — Constant structural differences between species occur in all organisms from the simplest to the most complex with the exception of the Bacteria, in which, according to the present view, the physiological differences are those which can be best employed for the recognition of species. In the Spirochaeta structural and physiological characters seem to be of equal importance. A comparison between the species or races of Bacteria and those of higher organisms is of doubtful value because of the more rapid multiplication of the former. In the higher plants, structural characters may show a remarkable amount of plasticity; among animals, some, such as the corals and particular genera of other groups, are equally plastic. Not enough is yet known to enable us to say whether the degree of plasticity is a real difference between animals and plants. If such a difference exists it is more likely to occur between motile and sessile organisms.

When closely allied species in various phyla are examined, it seems to result on the whole that no particular organ or system is especially differentiated. The differences that occur usually consist of slight divergencies in size, proportion, and colour and in the number of individual parts, such as the cusps of teeth or 'ornamental' bosses and lines on shells. On the other hand, in certain groups there is no doubt that secondary sexual characters stand out as being affected; though in some these are scarcely differentiated at all, for example in the Polychaeta, the Lamellibranchia, and some Prosobranchiate gastropods.

Of those forms which show such differences, some exhibit them in the organs connected with copulation, for example many of the Platyhelmia, a large proportion of the Arthropoda, Pulmonate gastropods, and many groups of mammals; while in birds other secondary sexual characters are affected. No other generalisation as to the structural characters which distinguish closely allied forms can be made; but the following points are worthy of attention. Species often differ in the frequency with which certain characters occur together; thus the common limpet (*Patella vulgata*) differs from the "flither" or low-water limpet (*Patella athletica*), with which it has many features in common, in that it possesses more frequently a broad shell and a grey foot, while the flither usually has a narrow shell and an orange-yellow foot. Many allied forms differ in total body size, though if their sizes were plotted graphically the frequency curves would overlap considerably.

It has been pointed out frequently that allied species tend to throw parallel variations; but it is equally true that one of two closely allied forms may be distinguished by its ability to throw some particular variant, for example, the fly *Dorniphora abdominalis* always has two antero-dorsal bristles on the hind tibia, while *D. florea* may have two or three (Lundbeck, 1922). Furthermore, species may be polymorphic in one part of their range and not in another, so that their races may differ in the ability to produce certain variants.

Colour differences between species are often held to be of great importance, but many cases are known in which such differences do not obtain, and it is uncertain whether colour is markedly affected at the onset of divergence. Some colour differences, for example melanism, constitute special problems which cannot readily be explained.

2. Physiological Differences.—Differences between species of the same genus have been reported in many activities and properties which we define as physiological and biochemical; for example, in actual metabolic processes and their products (including special secretions such as venoms), in the fertilisation reaction, and in the behaviour of grafts. In a wide sense physiological distinction is ultimately implied in all differences of structure and habit. If we consider measurable differences in metabolism only, it is very difficult to say whether a physiological differentiation parallel to that of structure is at all universal. The study of such processes is usually limited to different genera, and the differences between species are not often considered. Furthermore, when species of the same genus are examined, no allowance is made for individual idiosyncrasy, sexual and seasonal difference, and other factors important from the taxonomic point of view. There remains, however, some evidence which suggests that taxonomic species may be as clearly differentiated in their metabolic activities and products as in their structure; for example, in carbon dioxide output, certain properties of hæmoglobin, amount of blood-sugar, starches of plants, and the precipitin reaction of vertebrate blood. The data on most of these points, however, require investigation from the taxonomic point of view, and there is furthermore a real need for the study of the physiological differentia of closely allied species.

3. Reproduction.—The phenomena to be considered here include (*a*) breeding season, (*b*) mating habits, (*c*) coitus, (*d*) sterility, and may be considered in two ways, first as criteria of species and secondly as means of isolation. The latter will be more fully considered in a later section.

(*a*) *Breeding Season.*—In those parts of the world where there is marked seasonal change in physical conditions, the breeding period of animals and plants is more or less determined by such change, but within the somewhat wide limits of the general breeding period allied species may breed at different times. These differences may be absolute so that such forms cannot interbreed, or the two breeding seasons may have a larger or smaller amount of overlap. Some species, however, breed throughout the year even in temperate regions, while some allied forms breed at the same time of the year. We do not think there is at present enough evidence to determine whether differences in the breeding season are frequent in closely allied species.

(*b*) *Mating Habits.*—There are two main divisions of this subject—differences in mating-place and differences in mating-behaviour. Neither of these exist in many animals (*e.g.* sessile forms), and in others there is no definite mating-place as distinct from the general habitat.

Mating-Place.—In many cases physical conditions, such as light and temperature, control mating to a considerable extent, and it is quite possible that allied species may be isolated by definite requirements. Very little exact evidence, however, is available on this point. Many species choose particular mating-places which may or may not coincide with the nesting site. Thus Kemp (1915) records that while in *Palæmon malcolmsi* the male probably fertilises the female in fresh water outside the Chilka lake, in *P. rudis* the male accompanies the female into the lake. Both these species perform their migration when the lake is full of fresh water, while a third species, *P. lamarrei*, migrates into it in the brackish season. Comparable cases occur in fishes and birds. When the choice of mating-place involves migration the latter may take place from one particular area to another, so that allied forms are separated throughout the year; or it may take place from an area in which many species live together to a special area. In particular cases this choice of breeding-area may lead to isolation; though how often this results is uncertain.

Mating-Behaviour.—The complex behaviour that often occurs in this connexion may be divided into (1) expressions of excitement, (2) incitement and suggestion, and (3) various types of preliminary manipulation of the female. The second may include either specially developed ceremonies, for example the display by spiders of a special coloured patch, or the abortive use of behaviour included in (3); for example, in many insects the male will jump on the female's back long before coitus. Instances of specific differentiation may be found in all these types, but it is possible that it may be more marked in the second. When differences occur they are often as diagnostic as structural characters.

(*c*) *Copulation.*—The mechanics of coitus involve a complicated adjustment of the musculature and skeletal parts. Differentiation of the latter may be very frequent in intromittent and receptor organs and in parts developed for clasping. Connected perhaps with structural differences are differences in posture and the duration of coitus.

(*d*) *Sterility.*—The sterility which occurs when two species are crossed has often been supposed to be a special characteristic of such crosses. The incidence of sterility is, however, capricious, and no absolute correlation between it and structural divergence can be shown. There is, therefore, a danger of arguing in a circle as to the relationship of species, according as one or the other criterion is used. At present it is only the structural criterion which can be employed satisfactorily; for by this method the degree of sterility and other phenomena difficult of interpretation can be referred to a standard more easily fixed.

The capricious incidence of sterility was known to such an early worker as Kölreuter, and was further emphasised by Darwin and later workers. While sterility is well substantiated among species-crosses in general, the evidence is at present insufficient to decide whether *closely allied* forms are usually sterile. Various forms (for example, species of Drosophila and Poecilopsis), which must be regarded as very closely allied, show a high degree of sterility when crossed. On the other hand, fertility of varying degree may occur between structurally distinct forms which have even been placed in different genera, *e.g.* the mallard and pintail (Philipps 1915); *Xiphophorus strigatus* and *Platypoecilius maculatus* (Gerscheler 1914). In the Teleost crosses made by Newman (1916) one effected between different orders was as successful as that between species of the same genus. Thus it is evident that sterility does not necessarily precede structural divergence and is probably produced in many cases as the sequel to a certain degree of general differentiation. This view is substantiated by the occurrence of many degrees of sterility, of which the following are some examples :—

1. Absolute sterility. (*Poecilopsis isabellæ* and *lapponaria*, Harrison)
2. F^1 produced but with disturbed sex ratio, low vitality, or other abnormality. (Lymantria, Goldschmidt; certain Bistoninæ, Harrison.)
3. F^1 normal but sterile. (Mule.)
4. F^1 produced but weak. (*Drepana curvatula* and *falcataria*, Standfuss.)
5. F^1 healthy. (Antirrhinum, Baur; Bistoninæ, Harrison.)

Between most of the categories no definite distinction can be drawn; as, for example, two forms can only logically be called absolutely sterile if the sperm is unable to enter the egg, yet in practice they will be called sterile if the embryos are produced but die in early stages. If the embryos live a little longer they will be regarded as a sickly F^1. In addition to the categories listed above, it is sometimes found that the result of a cross between species depends on which of them provides the male and which the female.

In discussing sterility there is a danger of identifying phenomena which are only apparently similar (cf. Bateson 1912) and also of confusing sterility produced by unnatural condition with that due to genetic incompatibility. It is sometimes found that crosses at first unsuccessful are, under different conditions, quite fertile.

4. HABITAT-PREFERENCE.—In plants the habitat depends mainly on the physical and chemical factors of the environment, but in many animals an active search for more or less diverse foods determines the exact habitat almost as much as the other factors. Thus two species occurring in one plant habitat, but seeking diverse foods, may be exposed to very different conditions of competition and experience a certain measure of isolation.

Closely allied species of animals and plants may be found in different geographical areas or in habitats differentiated within the same area, and, so far as animals at least are concerned, our knowledge of their distribution is largely founded on the former. The importance of such geographical isolation is, however, uncertain unless at the same time the actual habits and mode of life are known. No two habitats in different countries perhaps can be identical, at any rate in the conditions of competition; yet conditions may be sufficiently similar for the amount of divergence attributable to them to be unimportant.

The occurrence amongst the majority of animals of specific differences in habitat between close allies is not easy to show at present. The geographical range of species may be known, but even in the commonest forms the number of plant-habitats, for example, in which they occur may be very uncertain. Amongst the forms of which the distribution is satisfactorily known, some species occur in the same habitat as their close allies, and some occur in separate ones. The common view that allied species always occur in separate habitats is by no means true. In many mammals the separation seems to be fairly complete; but this is not the case in some insects and Mollusca. When a species occurs in a particular habitat, it is often not restricted to it by a general adaptation but by a reaction to a particular factor. A habitat is usually defined by many factors, and the occurrence of a species in a particular habitat may be determined by different factors in different parts of its range. Structural modifications shown to be adapted to particular habitats or modes of life seem to be more characteristic of genera or groups of higher rank than of species. Thus, when allied species do occur in different habitats, it may not be because of any simple difference in them which could be the result of a single variation.

5. DIFFERENCES IN FOOD.—When animals live on organic débris or on food in solution, it is obviously impossible to say whether there is any difference of diet between species. When the feeding habits are more specialised, the food eaten by any species may consist of the members of a single species or genus, or of a larger range of forms. Differences in diet are not easily detected unless the range of foods is small; for when the diet is more varied a difference between allied species may relate only to a few components of the diet. In the latter case, the food-habits are rarely known well enough to differentiate species. Among insects there are many closely allied vegetarian forms which can be distinguished by the food-plant, though it is probable that such cases are not frequent in the rest of the animal kingdom. With a few exceptions, there is very little satisfactory evidence as to differences between closely allied species in this respect. When parasites are limited to specific hosts their distribution is probably determined by many factors besides food.

6. MISCELLANEOUS DIFFERENCES.—Many differences in habit between species will be recalled which are not considered in the previous discussion. The following are a few well-authenticated examples in closely allied forms. In the moths of the genus Nepticula, the larvæ of which are leaf-miners, the species are sometimes distinguished by the shape of the mine and sometimes by the way in which the larvæ dispose of their dung (Tutt 1899). G. T. Lyle (1925) records differences in closely allied species of Apanteles in the method of making cocoons. Closely allied forms of birds may differ in the degree of their timidity towards man (for example, the British and Continental robins) and in their alarm notes (meadow and tree pipits). Such cases show that habits just as structure are liable to differ specifically.

(*To be continued.*)

Stresses in Buildings.

By Prof. E. G. Coker, F.R.S.

The range and variety of the problems connected with the provision of safe and suitable buildings and structures have recently been brought to the attention of the British public in many ways, notably by a lack of housing accommodation, the insecurity of Waterloo Bridge, and the dangerous state of St. Paul's Cathedral. During the post-War period, the provision of new materials and improved methods of construction have also engaged the attention of eminent architects, engineers, and firms of constructors. Commercial buildings are in the main proceeding apace, where great capital interests are involved, as in Regent Street, London, or where private munificence is supplying the urgent needs of hospitals and educational institutions. New technical problems are in consequence arising, and will no doubt continue to present themselves under a condition of affairs in which methods of construction are rapidly changing and new materials are being pressed into service.

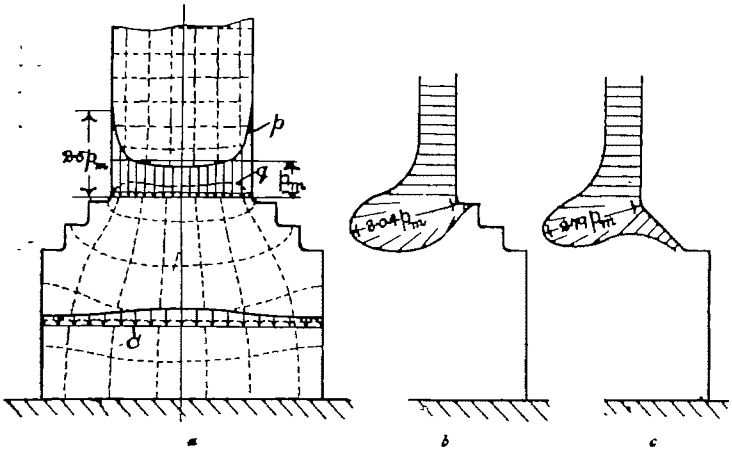

Fig. 1.—Stress distribution and lines of principal stress at the base of a wall.

Some elementary problems of this kind presented themselves recently during the partial completion of the engineering wing of University College, London, upon foundations built thirty years ago. These difficulties were dealt with successfully as they arose, but the absence of definite data in existing literature led to an experimental investigation on transparent models,[1] in which stress is measured by the temporary double refraction produced by load. One of these primary problems is the stress at the junction of a main wall with an enlarged base spread out in the usual fashion shown by Fig. 1, *a*, to afford a safe load on the earth below it.

It is at once apparent that, at the first sudden enlargement in such a wall, the stress at the angles must be extremely great, as experiments show, but for experimental purposes it is necessary to avoid an excessive concentration of stress at such places in order to measure the distribution. All such angles were, therefore, completed by a small circular arc in this case of radius $b/24$, where b is the breadth of the wall. With this modified arrangement, it was found that the stress at the horizontal cross section due to a mean vertical stress p_m rose to approximately $2{\cdot}5\ p_m$ at the junction with the wall, but is even greater at a point on the circular fillet just below this where it rose to $3{\cdot}04\ p_m$ (Fig. 1, *b*). The general vertical distribution p over this cross section is also accompanied by a variable cross stress q as indicated, while at *C*, well below the change of section, the tendency of the stress is to concentrate towards the centre, as my colleague, Prof. Filon, had already shown, mathematically, must be the case. It will also be noted from Fig. 1, *a*, that in the wall the tendency is exactly opposite. Monolithic walls are not usually constructed with stepped footings, but are connected to the base by sloping sides such as may be obtained when the projecting angles, Fig. 1, *a*, are removed, as in Fig. 1, *c*. This is found to result in a diminution of the maximum stress at the face of the wall to $2{\cdot}79\ p_m$.

Another problem of frequent occurrence is the stress effect due to a line of window openings, and represented here by two rectangular openings with rounded angles, Fig. 2, in a wall of limited width, such as might occur with some modifications and many more windows in a monolithic concrete wall of a building. The stress distribution here shows that at the cross section *AB*, the central part of the wall is under practically uniform stress, while the side walls are under nearly uniformly varying stress with maximum values at the window openings, accompanied by great local concentrations of stress at the rounded angles, and variable tension along the upper and lower boundaries of the window openings. This latter stress is unsuitable for masonry, brickwork, or concrete to bear, unless reinforced by steel, or, as in a high building, dealt with by a steel framework, which transmits the main load to the

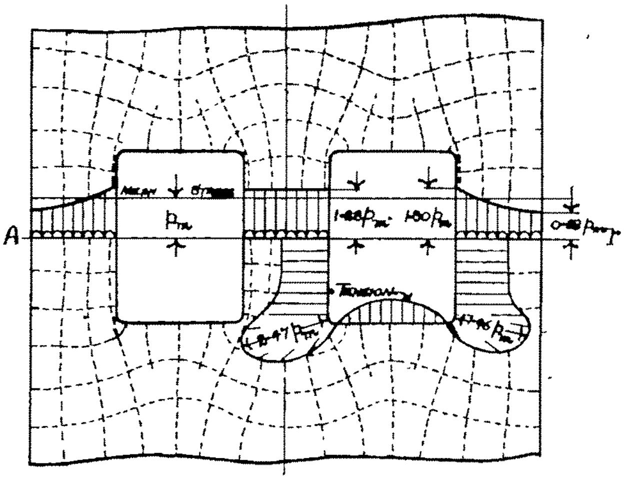

Fig. 2.—Stress distribution and lines of principal stress due to window openings.

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[1] For a description of the experiments, see the issue of February 6 of the *Journal of the Royal Institute of British Architects*.

foundations, leaving the walls a mere protecting cover of no structural importance.

Structural weakness in a building may also be produced by an excess of material placed there from purely artistic considerations, and a good example of this is an ornamental cornice, Fig. 3, such as may be found in, say, a Gothic cathedral structure. The effect of the projecting part is to cause a considerable change in the vertical directions of the lines of stress, as Fig. 3 indicates. Such lines are also found in the free projecting part and direct attention to the stress there. An examination of the stress across the horizontal joints shows that there is a great local increase of load at the face of the wall, which in this case causes an increase of stress of about 75 per cent. of the mean stress at this face, and is also approximately the same at the outermost point of the lower joint. It may happen, therefore, due to sinking of the foundations at one place, that a good deal of extra load may be thrown on another part of a wall, and the extra stress on a cornice may then rise to so great a value that the material at the face is crushed locally and cracks develop, which ultimately lead to the cornice falling down, as occasionally happens. The reason for this concentration of stress is not difficult to understand, if it is remembered that, in a simple rectangular block of masonry with plane joints and without projections, the compression stress is uniformly distributed, and the two horizontal faces approach one another by a small definite amount.

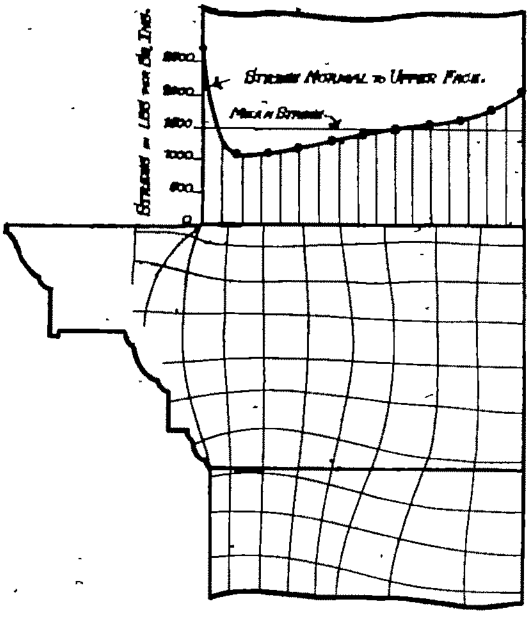


FIG. 3.—Stress effect of a cornice.

The effect of a projection such as a cornice is to resist alterations of the form of the block, more especially in its own neighbourhood, and in consequence the plane surfaces of the joints deform into slightly curved surfaces resulting in a higher stress developing at the ends and more especially at the face of the wall.

This example is one of many instances in construction where an addition of material causes increased stress, which must be taken into account where architectural or other requirements compel the use of excess of material in disadvantageous positions. Experiment in this case shows that some slight improvement in stress conditions is obtained when the cornice is itself of much less depth than the masonry block.

Obituary.

PROF. A. PEROT.

THE death of Prof. Alfred Perot on November 28, 1925, was a serious loss to French science. Perot was born at Nancy in 1863, and after completing his studies at the École Polytechnique at Paris, returned in 1884 to the University of his native town, where he undertook research upon the density of saturated vapours, obtaining experimental confirmation of the thermodynamic formulæ. In 1884 he commenced teaching at the University of Marseilles, where he also undertook investigations on the properties of dielectrics, and on Hertzian waves, and ultimately became associated with Charles Fabry in a series of researches on optical interference, particularly between plane parallel semi-silvered surfaces. The methods developed by Perot and Fabry have formed the basis for the precise determination of the values of the reference lines in the international system of wave-lengths now universally employed.

In 1901 Perot was entrusted with the task of organising a "Laboratoire d'Essais" in connexion with the Conservatoire des Arts et Métiers. While engaged on this task he continued his association with Fabry, and with the further collaboration of the late Dr. R. Benoit, then director of the Bureau International des Poids et Mesures, carried out by new methods a fundamental determination of the value of the metre in terms of the wave-length of the cadium red line, the result of which confirmed with truly remarkable precision the earlier determination of Michelson and Benoit. This determination remains the recognised standard of departure for wave-length values to the present time.

In 1908 Perot left the Laboratoire d'Essais to become professor at the École Polytechnique, and physical astronomer of the Observatory of Meudon, resuming his spectroscopic studies, particularly with respect to very small displacements of lines in the solar spectrum due to various causes. He continued to occupy himself with questions of measures and units, and succeeded M. B. Violle as president of the Commission de Métrologie Usuelle, in connexion with the French weights and measures service. He also took an active part, as president of the Special Commission de Refonte des Règles, in the preparation of the new French law on the subject (1923) whereby the definitions of the metric system were extended and amplified (for example, by the introduction of a system of units based on the metre, tonne and second [M] [T] [S]), with the view of increasing their applicability to the ordinary transactions of commerce and industry.

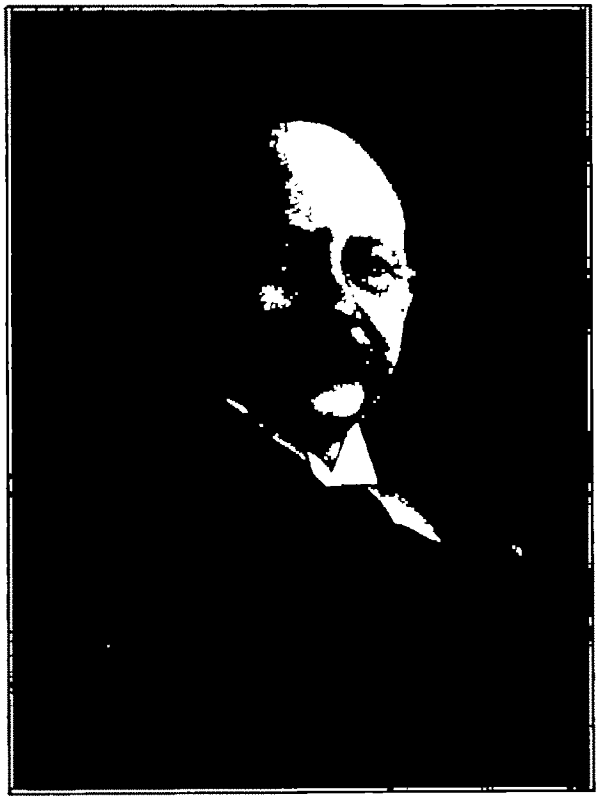
Perot was not only a sound theoretician and skilled experimenter, but also an excellent mechanic, who was well able to construct with his own hands the very delicate apparatus used in some of his investigations. During the War his time was mainly devoted to confidential researches connected therewith.

J. E. S.

PROF. H. KAMERLINGH ONNES, FOR. MEM. R.S.

PROF. HEIKE KAMERLINGH ONNES, whose death on February 21 will be widely regretted, was born on September 21, 1853, in Groningen. As a youth he attended a school in that town, of which J. M. Van Bemmelen, who later became professor at Leyden, and whose name will always be remembered in connexion with colloid chemistry, was principal.

In 1870 Onnes became a student at the University of Groningen, and from 1871 until 1873 he worked under Bunsen and Kirchhoff at Heidelberg. He remained in Groningen until 1878. His doctoral dissertation was entitled "New Considerations on the Axial Changes of the Earth," and was marked by the combination of theory and accurate experiment which is characteristic of all his later works. In 1881 he became influenced by the theories of Van der Waals and wrote an important paper in which he deduced the law of corresponding states from considerations of statistical mechanics.



HEIKE KAMERLINGH ONNES.

In the following year Onnes became professor at Leyden. In his inaugural address he insisted that the laws of physics could be determined by accurate experiment alone. His motto "From measurement to knowledge" was then stated for the first time, and his remarks upon the necessity of the then recently designed pumps of Cailletet and Pictet for the attainment of low temperatures were almost prophetic. It was about this time that Onnes planned his cryogenic programme, which has since made his name famous throughout the world. In 1894 he published his first paper on the design and equipment of the Leyden laboratories, and in his inaugural address in 1894 he laid down the importance of accurate measurements at very low temperatures.

The formation of the cryogenic laboratory at Leyden was only made possible by the extraordinary energy and tenacity, combined with organising talents of a very high degree, which Onnes brought to bear on this subject. As a preliminary it was necessary for him to train mechanics and glass-blowers, and as a result of many years of patient work he obtained an organisation which is still unique. In 1904 Onnes was able to control large supplies of liquid air. By 1906 he had developed the technique of the liquefaction of hydrogen on a large scale. In 1908 he attained the triumph of his career by liquefying helium. This feat, taking into consideration the limited supplies of helium and the difficulty in obtaining it in those days, was little short of superhuman.

The amount of careful organisation and planning necessary before the experiments were started can only be appreciated by those who have seen the laboratory in action. It is worthy of record that the whole staff was so tired out by their exertions that they could not see the helium even after it was liquefied. The presence of the liquid was pointed out to them by Prof. F. A. H. Schreinemakers, who was in the laboratory at the time.

The boiling-point of helium enabled Onnes to reach a temperature only 4·22° above absolute zero. By reducing the pressure he was finally enabled to arrive at a temperature of 0·9° absolute. The writer had the privilege of seeing Onnes attempt to solidify helium. A battery of fifteen large Langmuir pumps were put into connexion with a supply of liquid helium whereby the pressure was reduced to about 0·2 mm.; in spite of this, however, the helium did not solidify.

The ability to control really low temperatures enabled Onnes to make the astonishing discovery of supra-conductivity. It had always been assumed that the conductivity of a metal would run out to nil at the absolute zero. Onnes discovered that quite a number of substances showed a sharp discontinuity in their conductivity curves at a temperature of about 4° or 5° absolute. Typical examples are lead and cadmium. He passed a current of 1000 am./sq.mm. through a conductor under these conditions without being able to detect the slightest change of E.M.F.

Onnes's work is well summarised in the volume presented to him on the occasion of the fortieth anniversary of his holding the chair at the University of Leyden. Most of his work was published in the *Proceedings of the Physical Laboratory of Leyden*, and it is due to the comparative inaccessibility of this publication that Onnes's work is not so widely known as it should be.

It is impossible, within the limits of a brief notice, to give more than an idea of the scope and range of his activities. The division of the above-mentioned work into thermodynamic, magnetic, optical, magneto-optical, radioactive and electric sub-sections, in each of which he published numerous papers, is an indication of the magnitude of his work.

In later life Onnes received the fullest recognition of his great talents. His own country awarded him a Commandership in the Order of the Lion of the Netherlands. Similar decorations were conferred upon him by the Governments of Poland and Norway. In 1913 he received a Nobel Prize for physics. He was an honorary member of practically every learned society in the world. Onnes was awarded the Rumford medal of the Royal Society in 1912 and was elected a foreign member of the Society in 1916.

Turning to his personal side, it is impossible to speak of him without emotion. Onnes was one of the most genial, kind-hearted, and accessible men who ever lived. He made unremitting efforts towards the feeding of children in the destitute areas of Europe in the years immediately following the War. To young men, he was an inspiration. The writer will always remember, with gratitude, his extraordinary kindness and hospitality. He practically kept 'open house.'

Onnes's scientific memory is imperishable, and his personality will never be forgotten by any one who had the privilege of knowing him.

F. A. FREETH.

PROF. F. Y. EDGEWORTH.

BY the death of Prof. Francis Ysidro Edgeworth, fellow of All Souls College and emeritus professor of political economy at Oxford, on February 13, at eighty-one years of age, economists and statisticians alike have suffered a heavy loss. Born at Edgeworthstown, Ireland, in 1845, he was educated at Trinity College, Dublin, and Balliol College, Oxford, and was called to the Bar in 1877. Always a man of the widest interests—classic, mathematician, and philosopher—he was some time in finding his *métier*. Ethics and logic first gave scope to his abilities, but with his appointment as Tooke professor of political economy at King's College, London, in 1890, and his migration to Oxford as Drummond professor in 1891, the trend of his life's work was fixed.

On the foundation of the Royal Economic Society in 1890, Edgeworth became editor of its organ, the *Economic Journal*, and but for one short interval remained co-editor until his death. His early volume, "Mathematical Psychics" (Kegan Paul, 1881), dealing with the application of mathematical methods to economics, is in many ways very characteristic, not only in subject but also in style; in the fact that nearly half the small volume consists of appendices, as many of his later papers bristle with footnotes, and in the adornment of the text by quotations from the Greek. Olympian Zeus, Here, and Athena are but rare visitors to the pages of most economists! His numerous economic writings, for the most part on abstract theory and covering a very wide field, were recently reprinted by the Society in three handsome volumes (Macmillan and Co., 1925), and well exhibit the detached and acutely analytical character of his mind. A fellow of the Royal Statistical Society since 1883, he was awarded the Guy gold medal of the Society in 1907, and in 1912–14 held the office of president.

In statistics, Edgeworth's work was mostly concerned with the theory of error, averages, the normal distribution and its generalisations, and—as mundane a subject as perhaps he cared to touch—index-numbers. He was secretary of the British Association Committee "appointed for the purpose of investigating the best methods of ascertaining and measuring variations in the value of the monetary standard" and responsible for its classical reports (1887–90). The subjects chosen for his two presidential addresses to the Royal Statistical Society, "On the Use of the Theory of Probabilities in Statistics relating to Society" (1912) and "On the Use of Analytical Geometry to represent Certain Kinds of Statistics" (1913), show the bent of his mind. From the first paper he contributed to the very last—a note on "The Element of Probability in Index-numbers" in the *Journal of the Royal Statistical Society* for last July—all exhibit his lively but distinctly difficult style, leaping from one illustration to another: fluctuations of sampling in human statistics elucidated indifferently by counts he had made of the numbers of wasps entering and leaving a nest, or the numbers of dactyls in Virgilian hexameters. Young to the last, in spite of his years, courteous, humorous, and kindly, he will be greatly missed.

REV. S. J. WHITMEE.

THE Rev. Samuel James Whitmee, who died in London on December 10, was born at Stagsden, Bedfordshire, in 1838, and went to Samoa on behalf of the London Missionary Society in 1863, where he remained until 1877. During this period he contributed many notes to NATURE, including "Earthquakes in the Samoan Islands, South Pacific," "Origin of Cyclones," "Meteors in South Pacific," "Fauna and Flora of New Guinea and the Pacific Islands," and in vol. 12 (1875) a criticism of Prof. Dana's review of Darwin's "Coral Reefs," entitled "Mr. Darwin and Prof. Dana on the Influence of Volcanic Action in preventing the Growth of Corals." His other publication included a list of Samoan birds in *Ibis*, vol. 5; "On the Manifestation of Anger, Fear and other Passions in Fishes" in the *Proceedings of the Zoological Society* for 1878; and a paper on "The Ethnology of the Pacific" in the *Victoria Institute Journal*, vol. 14 (1881).

Mr. Whitmee collected and forwarded to Kew numerous botanical specimens, the ferns of which formed the subject of two papers by Dr. J. G. Baker in the *Journal of Botany* for 1876, in which fourteen new species were described. His other natural history specimens were sent to the British Museum.

Returning to England in 1877, Mr. Whitmee engaged in ministerial work, but returned to Samoa in 1891, where he became the close friend of R. L. Stevenson, to whom he taught the Samoan language. Whitmee finally returned to England in 1894 and settled down at Barnet.

C. H. W.

WE regret to announce the following deaths:

Prof. A. R. Cushny, F.R.S., professor of materia medica and pharmacology in the University of Edinburgh, on February 25, aged sixty years.

Prof. F. Roth, emeritus professor of forestry in the University of Michigan, known for his work on the technical properties of timber, on December 4, aged sixty-seven years.

Mr. W. F. Wells, president in 1911 of the British Pharmaceutical Conference and twice president of the Pharmaceutical Society of Ireland, on January 28, aged seventy-six years.

News and Views.

GENERAL satisfaction will be felt at the fact that the Board of Trade has appointed to the Comptrollership of the Patent Office a man who is qualified for the post by definite scientific training. Mr. W. S. Jarratt, the new Comptroller, after becoming an Associate of the Royal College of Science spent some time in research under Sir Norman Lockyer. He next went to Trinity College, Cambridge, as a scholar, became a wrangler, and also obtained a first class in the Natural Sciences Tripos. He then entered the Patent Office as an assistant examiner, and eventually was appointed Assistant Comptroller for Trade Marks. He was called to the Bar in 1910. This is the first time that a Comptroller having scientific qualifications has ever been appointed. Since it became known twelve months ago that ill health was likely to compel the retirement of Mr. Temple Franks, who has done so much by the soundness of his judicial decisions to raise the legal status of the Patent Office to a high level, the problem of the selection of a successor has caused considerable anxiety in circles representing applied science and invention.

THE importance for industry of the principle that the head of the Patent Office should be a scientific man was pointed out some time ago in our columns, and much public interest in the whole question has been aroused. It is believed that the wise step taken by the Board of Trade has given widespread satisfaction, for although strong pleas have been put forward for the policy of raising the salary of the Comptrollership to a substantial figure and throwing the appointment open to general competition, the present demand for public economy must have precluded the adoption of such a plan, and the Treasury may be considered singularly fortunate to have obtained by more conservative measures a man with such excellent qualifications for the post. The position of the new Comptroller is not likely to prove a bed of roses, for there is an urgent demand for various reforms in the patent system, and it will fall to him to advise the Government as to any new legislation which may be necessary in this connexion. It seems safe to assure him, however, of the sympathy and support of the scientific world in handling the intricate and difficult problems which confront him.

FOLLOWING the application of the surgeon's knife to the excessively swollen capital of the British Dyestuffs Corporation, Ltd., the patient is beginning to show signs of convalescence and new energy. On February 26 it was officially announced that the Corporation had acquired a majority of the share capital of Scottish Dyes, Ltd., and that the management of the latter company would continue in the same hands, Mr. James Morton remaining chairman and Dr. J. Thomas, managing director. The board of the Corporation, which was recently strengthened by the appointment of Dr. A. Rée, will now receive the expert assistance of Mr. Morton; and the accession of Sir William Pope to the board of Scottish Dyes, Ltd., will be hailed with satisfaction by the many who believe that no board of this kind is complete unless science is adequately represented upon it. It is also announced that in future the manufacture of vat-dyestuffs will be concentrated at the works of Scottish Dyes, at Grangemouth.

THE process of aggregating brains and capital and of segregating manufacture to chosen works, which seems to be the policy of the British Dyestuffs Corporation, Ltd., is familiar to us from the history of the *Interessengemeinschaft*, and we see no reason why its success in Germany should not find a parallel in Great Britain. During the War, Mr. James Morton showed great enterprise in embarking upon the perilous sea of dyestuff manufacture, and by successfully specialising in the production of 'shades,' he acquired a well-deserved reputation. Since then he has initiated and developed the manufacture of vat dyes at Grangemouth; in fact, his policy has been almost the reverse of that pursued by the Government-aided corporation, which, in its endeavour to monopolise the home industry, entered indiscriminately upon the manufacture of a host of products, with the result that it brought few of them to a state of perfection. At the time when demand greatly outran supply, the latter policy was intelligible, but now that dye-producing capacity is everywhere in excess of consumers' needs, the only way of salvation is to concentrate upon quality, low production costs, and efficient salesmanship.

IN August last, a gentleman who desired to remain anonymous, called at the London Hospital and stated that he wished to make a gift for some charitable purpose and asked advice as to the best way of doing so. Eventually it was agreed that most good could be done by endowing medical research in connexion with the Hospital. It was explained to the donor that such research is badly handicapped in that there is little possibility of a man taking it up as a life-work unless he has means of his own. Finally a trust deed was agreed on stating that the income should be spent in salaries, and not on 'bricks and mortar' or laboratory equipment, which it was thought the Hospital itself ought to provide. Later, the donor presented 50,000*l*. and the fund has been named the Freedom Research Fund. Its working is managed by a small committee consisting of a nominee of the donor, the head of the Clinical Laboratory, and the House Governor of the Hospital. Provision has been made for an annual scholarship in pathology of 100*l*. open to students of Oxford and Cambridge, a research studentship of 400*l*. a year for three years, to which Mr. L. Hewitt has been appointed, and the remainder of the fund between two senior pathologists to enable them to devote their whole time to research. Dr. S. P. Bedson, of the Lister Institute, and Dr. W. Howard Florey, of the University of Cambridge, have been appointed for this latter purpose. These workers will have the advantages that they will be engaged entirely on research work, but shoulder to shoulder with the Hospital Laboratory staff doing the routine investigation work of the Hospital; they will be in touch with the clinical work of the Hospital and especially with the Medical Unit; and they will be working in a centre where unlimited clinical material is available. It is hoped to enlarge this fund.

M. H. PARODI, the chief engineer of the Paris-Orleans Railway Company, read an interesting paper on railway electrification to the Institution of Electrical Engineers on February 18. Since the War, the development of electric railways and the suburban supply of electricity has been very rapid in France. The scheme on which M. Parodi is working is to substitute electric for steam traction on a line where the traffic is very heavy, and to provide a power transmission system for all the districts through which the railway passes. In France, the electrification of the railways forms part of a general network for power supply. This network will be built up gradually by linking together many of the existing distribution systems. The policy adopted by France of co-ordinating the supply of electric power to the railways with the general supply of power is different from that adopted by Germany, Switzerland, Austria and other countries, where the electric traction problem is considered without reference to power supply. If the power transmission lines were to follow the railway from Paris to Toulouse through Orleans, Limoges and Brive, then the great steam power stations of the Paris district could be linked with the hydro-electric stations of the Central Plateau and the Pyrenees. From the electrical point of view the use of very high voltages presents many advantages. Such lines are affected very little if at all by atmospheric phenomena. Whilst the power that can be transmitted varies as the square of the voltage, the first cost only varies directly as the voltage. With the pressure of 150 kilovolts now in use, it is possible to transmit economically 50,000 kilowatts from the Central Plateau to Paris, a distance of about 280 miles. It will be of interest to see how the relative cost of generating electricity by water power and by steam in France works out in practice.

DR. C. HAGBERG WRIGHT took for the subject of his discourse delivered at the Royal Institution on February 26 a remarkable but little-known personality in the literary history of France, the Sieur Nicolas Fabri de Peiresc, a gentleman of France, in the early seventeenth century. Peiresc, whose fame has suffered from the modesty of his character, was satisfied to minister to the needs of his brother authors and scientific workers, without desiring personal reward. Accordingly he gave, lent and borrowed books for his friends, and kept two bookbinders and an engraver continually employed. He had also in his household an astronomer named Garrat, having built an observatory where he carried on astronomical observations by the aid of a telescope constructed by Galileo himself. His studies took a wide range, including astronomy, numismatics, ancient inscriptions and monuments, optics, music and horticulture. Without being, strictly speaking, a pioneer in any of these subjects, it was through his efforts that many aids to science were brought into France, and also valuable manuscripts obtained from Egypt, Cyprus and Syria. Through him the microscope found its way from Holland, where it was invented, into France. In optics his observations were in advance of his contemporaries, and he is said to have been the first to observe the phenomena of negative and positive after-images. In astronomy he co-operated with Gassendi during several years. Towards the end of Peiresc's comparatively short life his love of botany and horticulture became his supreme pleasure. His correspondence with l'Escluse, the great Dutch botanist, remains to testify to his ardour in this direction. Incidentally, Peiresc is believed to have introduced the tulip into France, after it had been brought from Constantinople by an Austrian diplomat, named Busbecq, in 1562, and by l'Escluse carried to Holland, whence Peiresc obtained it. After fifty-seven years of untiring activities Peiresc succumbed to the ill-health which had accompanied him through life.

DR. H. T. CALVERT, of the Ministry of Health, delivered a Chadwick Public Lecture on February 26, taking as his subject, "The Activated Sludge Process of Sewage Treatment." He stated that no aspect of the sewage purification problem has been so much discussed since the War. The process has been developed from the older methods including land irrigation and treatment in contact beds or percolating filters; the activated sludge is obtained from the sewage itself by means of aeration and is then used for the purification of further quantities of sewage. Various methods of applying the process have been invented, all of which aim at oxidising the organic matter of sewage, by means of air and micro-organisms, in the most efficient manner and at the lowest possible cost. As compared with ordinary sludge, activated sludge is of higher manurial value, but the difficulty of removing the water which adheres to the sludge will no doubt stand in the way of a general adoption of the process and a full utilisation of activated sludge as a manure. The capital expenditure to which local authorities in Great Britain are already committed for applying the activated sludge process amounts to approximately one million pounds sterling and a larger amount has already been spent on the process in the United States. Dr. Calvert concluded by asking for more extended scientific investigations of the process, with the view of furnishing the necessary information for the design of further works.

SOME interesting suggestions are put forward by a correspondent in the *Times* of February 24, relative to the origin of the type of the Amenhetep temple at Beisan in Palestine. This temple was one of four of different dates, three being superimposed, discovered during 1925 by the expedition of the University Museum, Philadelphia. It belongs to the Amarna period, in itself a matter of considerable interest, and is very similar in style to the tomb chapels found at El-Amarna. At the same time the cult objects found in the temples of Seti I. and Rameses II. at Beisan show a resemblance to cult objects from the temple of Ishtar at Assur, in which the cult-room is not so much Assyrian as comparable in type with that of temples at Bogazkeui, the Hittite capital. The existence of an Assyrian colony in Anatolia at the end of the third millennium B.C. appears to supply a link, and the suggestion is thrown out that the temple of Amenhetep at Beisan, which has a certain similarity to the cult-room, may have been built after the model of a Hittite temple and itself have influenced the form of the Amarna tomb-chapels. This latter somewhat unexpected and, some may think, improbable suggestion will give an added interest to the results of further excavation.

DR. T. W. GANN, in the course of a series of articles contributed to the *Morning Post* in the issues of February 22 and the two succeeding days, chronicles one of the most important finds of recent years for the history and chronology of the Maya in Central America. He has found in the Territory of Quintana Roo, Yucatan, a stele with an inscription, which contains the Maya Initial Series Date, 9.8.0.0.0.5. Ahan, 3 Chen, or October 26, A.D. 333. This date is more than 300 years earlier than that appearing on the oldest of the stelæ previously found, and is one of only four such Initial Series Dates found among all the Maya ruins in Yucatan. In view of the importance of fixing the date when the Maya first established themselves in Yucatan, this discovery, as Dr. Gann points out, "may cause a complete reversion of the ideas generally held as to their first immigration into this peninsula and their foundation of what is known as the New Empire."

THE forty-eighth annual general meeting of the Institute of Chemistry was held on March 1, Prof. G. G. Henderson, president, in the chair. The Meldola Medal was presented to Dr. Henry Phillips. In moving the adoption of the annual report, which showed that the roll of the Institute now numbers nearly 5000 fellows and associates, the president referred to the decrease in unemployment in the profession, and mentioned that there are indications that not only those industries which are strictly chemical in character but many others are also finding that well-trained research and analytical chemists are necessary to combat the effects of industrial depression. To some extent, the situation has been relieved by members passing into other work and also owing to the fact that the output of chemists from the universities has been less during the last two or three years. The Committee of the Institute has been concerned with matters affecting fertilisers and feeding stuffs, in which valuable assistance was rendered to the Ministry of Agriculture and Fisheries; with the Royal Commission on National Health Insurance, on which the Council represented the views of public analysts responsible for the examination of drugs under the Sale of Food and Drugs Acts; with the Labour Party on the subject of Government scientific publications; and also with the Director of Public Prosecutions. The local sections of the Institute have become increasingly active. The problem of seeking statutory powers of registration for professional, consulting and analytical chemists has been under the earnest consideration of the Council. Prof. G. G. Henderson was re-elected president of the Institute.

THE second Italian National Congress of Pure and Applied Chemistry, to be held in Palermo, opens with a reception in the Botanic Garden on May 22 next and closes on June 2. Many well-known chemists have already made known their intention to be present, and a large attendance is expected. In addition to meetings of the Congress and of its various sections, and visits to works and to places of interest in the neighbourhood of Palermo, the provisional programme comprises a five-days' tour, during which opportunities will be afforded to see Girgenti and its temples, mines and industrial establishments, Syracuse, the asphalt deposits of Ragusa, Catania and its sulphur refineries, Etna, Taormina, Messina, etc. The meetings of the Congress are divided into three groups, dealing with (1) questions of scientific or industrial importance, (2) communications to several sections jointly, and (3) papers and discussions relating to different chemical industries and to branches of pure chemistry. Any chemist wishing to read a paper before Group 1 of the Congress is requested to furnish the General Secretary, Via IV Novembre 154, Rome 1, with a summary of his communication not later than April 30, while for Group 3 the Secretary should be informed of the title by April 30 and should be supplied with the text, together with a résumé, by May 10. Fifteen minutes will be allotted to the reading of each paper, and not more than forty minutes to a discussion of general interest.

THE Wilde memorial lecture of the Manchester Literary and Philosophical Society is to be delivered by Prof. G Elliot Smith on "Brains of Apes and Men," at 4 o'clock on Tuesday, March 9.

THE recent issue of the index parts of the Physics and Electrical Engineering Sections of Volume 28 completes *Science Abstracts* for 1925. The Physics Section has viii + 1045 pages, of which 41 are devoted to a name index, and 98 to a subject index. The number of abstracts of papers is 2808, and their average length 0·32 of a page. The Electrical Engineering Section has viii + 692 pages, with 23 for name and 51 for subject indexes, and 1811 abstracts of average length 0·34 of a page. As compared with last year the Physics Section has decreased by nearly 200 pages, and the Electrical Engineering Section increased by 40 pages. In both sections there has been a decrease in the average length of an abstract, which in the previous year was 0·36 of a page. So far as we have been able to judge during our use of the abstracts, this decrease of length has not been accompanied by a decrease of value, but is rather a proof of the increased skill of the abstracting staff. To the regular user of *Science Abstracts*, the attitude of the physicist or electrical engineer who regards it as unnecessary is difficult to understand—it seems like prospecting without a pick and shovel.

THE second issue of the *Journal of the Royal Technical College* (Glasgow) is of interest from more than one point of view. In the first place, it demonstrates the high standard of research which is being carried out in the College, and, secondly, it represents a serious attempt to add another to the list of well-recognised periodicals in which research work may find the light. The fifteen original pieces of work published are very much more than merely students' contributions, and the names of Profs. Caven, Wilson, Andrew, Kerr, Mellanby and Ellis are all found among the contributors to this single number; this is in addition to other work they may have published elsewhere. The general standard of papers is undoubtedly high. As an indication of the ground covered it is sufficient to enumerate the individual contributions: The magnetic properties of permalloy, the measurement of rapidly fluctuating temperatures; the production of hydrogen by steam in a hot boiler tube; the presence of air in pure and alkaline water; the pseudo-alums; additions to our knowledge of azoxy compounds, reactions of semicarbazides; some acyl derivatives of hydrazine; the separation of the components of petroleum; the crystalline structure of metals; specific volume determinations of carbon and chromium steels; the evaporative condenser (a paper of 38 pages); a note on blade stresses in nozzle controlled turbines, compression losses in divergent jets, and an investigation into the cause of the blackening of the sand in parts of the Clyde estuary. The issue, like the previous one, is excellently printed and illustrated. Every one interested in the progress of science, especially perhaps in its more practical applications, will join in wishing this, the latest among the scientific journals devoted to the publication of the results of original work, a very long and prosperous career.

THE Barclay Memorial Medal for 1925 of the Asiatic Society of Bengal has been awarded to Lieut.-Col. J. Stephenson, lecturer in natural history in the University of Edinburgh, in recognition of his work as a biologist and as the founder of the School of Zoology in Lahore.

THE ninth Silvanus Thompson memorial lecture of the Röntgen Society will be given on Tuesday, March 30, in the Barnes Hall of the Royal Society of Medicine, by Sir John Thomson-Walker, who will take as his subject "Radiology in Urinary Surgery."

DURING the last five or six years there has been a slight renewal of activity in the well-known earthquake centre at Comrie in Perthshire, and a shock was recorded on February 21 at 4.24 A.M. The tremor was evidently slight, lasted only a few seconds, and was accompanied by the usual sound resembling muffled thunder or an explosion.

AT the annual meeting of the Geological Society of London, on Friday, February 19, the following officers were elected: *President*, Dr. F. A. Bather; *Vice-Presidents*, Dr. J. W. Evans, Sir Thomas Holland, Mr. H. W. Monckton, Sir Arthur Smith Woodward; *Secretaries*, Mr. W. Campbell Smith, Dr. J. A. Douglas; *Foreign Secretary*, Prof. J. E. Marr; *Treasurer*, Mr. R. S. Herries.

THE second Italian National Congress of Pure and Applied Chemistry, to be held in Palermo on May 22-June 2 next, will be made the occasion of the celebration of the centenary of the birth of Stanislao Cannizzaro, which occurred in Palermo on July 13, 1826. On May 24, the body of the great Italian chemist is to be conveyed to the Pantheon, and this ceremony will be followed by the inauguration of the monument erected to his memory.

DURING the month of March, Miss Elizabeth Keith will exhibit at the Royal Anthropological Institute a number of her water-colour sketches of natives of Japan, Korea, China, and the Philippines and of the Ainu. Although in some cases, especially as regards the natives of the Philippines, it is permissible to doubt the purity of some of her types, Miss Keith has on the whole been happy in her choice of subjects, the Ainu, not unnaturally, being the most interesting and possibly the most picturesque. Admission to the exhibition is free.

IT is interesting to note that Sir John Marshall, in his further account of explorations on prehistoric sites in the Punjab and Sind in the *Times* of Feb. 26, records the occurrence of a similar chalcolithic culture at Nal, some 250 miles south of Quetta, in the Jhalawar country of Baluchistan. Polychrome pottery, analogous to that found at Mohenjo-Daro and Harappa, as well as copper implements, grindstones, and other small objects, have been found in a burial-ground in which the dead are buried in sun-dried brick graves or directly in the ground. This marks a distinction from the Mohenjo-Daro and Harappa sites, where at this early period the dead were cremated. The complete skeletons found at Mohenjo-Daro, it is said, are probably to be attributed to the beginning of the Christian era.

WE learn from a recent issue of the *Weekly News Bulletin* of the U.S.S.R. Society of Cultural Relations with Foreign Countries, that at the first meeting of the Academy of Sciences at Leningrad in 1926 a number of new honorary members were elected. The list includes: Prof. A. Svante Arrhenius (Stockholm); Prof. H. A. Lorentz (Leyden); Prof. Max Planck (Berlin); and Prof. Vito Volterro (Rome). The list of correspondents elected includes: Prof. A. Sommerfeld (Munich); Prof. Emil Abderhalden (Halle), Prof. G. Urbain (Paris).

AN Easter tour to the Valley of the Dordogne, lasting from April 1 until April 15, has been arranged by Prof. Patrick Geddes. The headquarters of the party will be Les Eyzies and, afterwards, at Domme. From Les Eyzies visits will be paid to all the more important caves and sites of prehistoric discovery in the neighbourhood. By permission of the Ministry of Public Instruction, M. Peyrony, Conservateur du Musée Archéologique, the well-known French archæologist, will act as guide and will also demonstrate the important collections in his museum. From Domme a series of daily excursions devoted to the regional survey of the geography and history of the most attractive part of the Dordogne Valley will be conducted by M. Paul Reclus, formerly professor of geography at Brussels. Full particulars of the tour may be obtained from Miss Jowett, 152 Abbey House, Victoria Street, London, S.W.1.

APPLICATIONS are invited for the following appointments, on or before the date mentioned:—A professor of mechanical and electrical engineering at the Artillery College, Woolwich—The Assistant Commandant, Artillery College, Red Barracks, Woolwich, S.E.18. A research mycologist in the Department of Agricultural and Horticultural Research of the University of Bristol, Long Ashton—The Registrar of the University (March 22).

Our Astronomical Column.

A LARGE SUNSPOT.—A spot now on the sun's disc has been seen with the naked eye, thus making the fifth of its kind to be recorded since the beginning of the year. The spot is of recent origin, as no trace of it was seen on February 9, when its position would have been near to the receding west limb of the sun. Its shape is somewhat irregular, and its size is about half that of the great spot of last January. Further particulars are as follows:

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Area
5	Feb. 25-(Mar. 10)	March 3·6	27° S.	1/600

(Area expresses the proportion covered of the sun's hemisphere.)

RECURRENCE OF MAGNETIC 'STORM.'—On February 23, a considerable magnetic disturbance commenced at 16¼ hr., reached its greatest intensity between 13 hr. and 19 hr. on February 24, and died away by about 5 hr. on the following morning. The greatest range shown by the declination magnet throughout the disturbance was a little more than 1°. Bright moonlight probably prevented the observation of aurora, which would be a likely phenomenon on the nights of February 23 and 24. The interval between the commencement of this magnetic storm and the preceding one on January 26 is 28·0 days. The sunspot disturbance, with which it is presumably related, is in solar latitude 22° (see NATURE, Feb. 6, p. 208). The time taken for a spot at this latitude to make one complete rotation relative to the earth is, on the average, 27·6 days.

As evidence of the existence of a relationship between sunspots and magnetic disturbances, Mr. E. W. Maunder showed from the Greenwich magnetic and sunspot data that the latter frequently recur at intervals of about 27 days, corresponding to the average period of the sun's rotation relative to the earth as given by sunspots (*Monthly Notices R A S.* 65, 2-34, 1904). The last two 'storms' provide an example of such a recurrence.

THE SPECTRUM OF THE RECENT AURORA.—In a letter received from Prof. L. Vegard, Universitets Fysiske Institut, Oslo, an account is given of the aurora of January 26, which appeared at the time of the magnetic storm noted in NATURE for February 6. Prof. Vegard writes that the striking feature of this aurora was its intense red colour, which spectroscopic analysis showed was mainly due to one single sharp line in the red, about $\lambda = 6323$ Å.U. Spectrograms taken at Oslo and Tromso also showed the characteristic auroral spectrum consisting of the 'auroral line,' 5577 Å.U., and the negative bands of nitrogen. The prominent red line has been recorded on two previous occasions at Tromso in 1923–24, and its mean wave-length deduced from the three observations is 6322·4 Å. Prof. Vegard states that the line, which is of the same character as the 'auroral line,' cannot be due either to hydrogen, helium, oxygen, or the ordinary spectrum of gaseous nitrogen. When, however, solid nitrogen is bombarded with cathode rays, two pairs of narrow bands (N_1N_2) and (N_3N_4) appear in the red and green parts of the spectrum. The relative intensities and character of these bands vary considerably with the magnitude of the nitrogen particles, the properties of the electric discharge, and when an inert gas, such as neon, is introduced (see also NATURE, May 1924, p. 716, for Prof. Vegard's account of his investigations of the auroral spectrum). From these laboratory experiments, Prof. Vegard thinks that this red line, 6323, is to be regarded as the limiting aspect of the band N_2, just as he considers the auroral line, 5577, to be the limiting aspect of N_1. Moreover, the study both of the luminescence spectra of solidified gases and the oscillation band series suggests to him that the changes of colour so frequently observed in auroræ may result from a transformation of the spectrum due to oscillations.

Another letter, received from the Chief of the Polish Maritime Station at Danzig, gives observations of the same aurora seen at that place and at the Hel peninsula. The colour is described as varying from brick-red to dark carmine and its brightness as being very variable.

Attention may be directed to two other recent contributions to the problem of the auroral spectrum appearing in *Proc. R S.*, Series A. vol. 106, p. 117 and p. 138, by Lord Rayleigh, and Prof. McLennan and Dr. Shrum, respectively.

COMETS.—Ensor's comet is now well placed for observation in the morning; it is moving north so rapidly that it will soon be observable throughout the night. The following ephemeris is for 6^h A.M.:

	R.A.	N. Decl.	log r.	log Δ
Mar 4.	$21^h\ 2^m\ 48^s$	21° 4′	9·8124	9·9643
8.	21 13 23	30 33	9·8661	9·9481
12.	21 28 14	40 13	9·9134	9·9419
16.	21 48 56	49 36	9·9552	9·9466
20.	22 17 48	58 12	9·9928	9·9616

Its naked eye visibility during this period is doubtful, but it will probably be an easy telescopic object. On the morning of March 8 it will be ¼° east of Zeta Cygni, on March 14 1¼° east of Rho Cygni. It then passes through Cepheus and the northern part of Cassiopeia.

Blathwayt's comet has grown fainter, but should still be within reach of moderate apertures. The following ephemeris is for 0^h:

	R.A.	N. Decl.	log r	log Δ
Mar 4.	$5^h\ 53^m\ 14^s$	42° 47′	0·2055	0·0123
8.	5 41 24	43 50	0·2140	0·0620
12.	5 32 35	44 30	0·2225	0·1061
16.	5 26 1	45 3	0·2312	0·1462

The comet is in Auriga, moving nearly parallel to the line joining Beta to Alpha.

Tuttle's comet may be visible with moderate apertures when the moon is absent. The ephemeris for 0^h is:

	R.A.	N. Decl.	log r.	log Δ.
Mar 3.	$1^h\ 21{\cdot}7^m$	30° 43′	0·1222	0·2249
11.	1 52 1	28 25	0·0991	0·2226
19.	2 22·2	25 49	0·0769	0·2212

Prof. A. Dubiago gives the following hyperbolic elements for Van Biesbroeck's comet, based on observations on Nov. 19, Dec. 4 and 21, Jan. 12.

$$\begin{array}{ll} T & 1925\ \text{Oct.}\ 3{\cdot}00066\ \text{U.T.} \\ \omega & 106^\circ\ 25'\ 13{\cdot}0'' \\ \Omega & 334\ \ 34\ \ 29{\cdot}9 \\ i & \ \ 49\ \ 10\ \ 38{\cdot}4 \end{array} \Bigg\}\ 1925{\cdot}0$$

$\log q$ 0·19500,
e 1·002442

Research Items.

RECENT STUDIES OF PITHECANTHROPUS. — In *Natural History*, the journal of the American Museum of Natural History, Vol. 25, No. 6, Dr. J. H. M'Gregor summarises recent views on *Pithecanthropus erectus*, but in addition contributes to the discussion of the place of these remains in our knowledge of the phylogeny of man the conclusions at which he himself has arrived as the result of first-hand study of the bones themselves and of Dr. Dubois' endocranial cast. Owing to erosion of the outer bone by the action of sulphuric acid, casts of the calvarium give an erroneous impression which can only be corrected by examination of the actual bones. 3·5 millimetres and more must be added to the maximum length, making it 184 mm. Further, the nuchal surface of the occiput to which the powerful neck muscles were attached has also suffered. The original occipital slope was therefore more vertical and consequently more ape-like than the cast. The corrected breadth measurement, allowing for erosion, gives an index of 71·5. In the endocranial cast both the development of the so-called Broca's convolution and the marked expansion of the middle temporal convolution support the view that Pithecanthropus could produce and appreciate articulate speech. In a reconstruction of the size and form of the brain made by Dr. M'Gregor, the hominoid features outweighed the pithecoid very decidedly and gave a volume of 940 cc. The general brain form is more like the gibbon than the gorilla, though in convolution it is more like the latter. In both size and form, however, the brain is distinctly closer to man than that of any ape.

THE SIGNIFICANCE OF THE CHARACTER OF THE HAIR IN MAN.—Dr. Fritz Sarasin has contributed a study of changes in the character of the hair in Melanesian and African children to *L'Anthropologie*, T. 35, pts. 5-6, in which he arrives at conclusions of no small importance in relation to the question of the significance of hair as a criterion of race. It has been stated by Martin that the form of hair characteristic of the different races is already to be observed in the newly-born, and the same or similar statements have been made by other anthropologists. Dr. Sarasin is unable to endorse this view as a result of his observations among the Melanesians and Africans. Among New Caledonians, infants up to the age of a year or a year and a half have almost straight or slightly wavy hair, of brown, light brown, or even blond. It does not begin to change until about five years, and does not become completely frizzy like that of an adult until about six years, when it is still slightly lighter in colour. This observation is supported by the records of observers in the New Hebrides (Speiser, Heim), in Africa (Collignon, Frédéric, Junod, Borel), and among the negroes of the United States (Schultz). Among negroes, however, the hair is black and not lighter in colour, and the change in form takes place rather earlier. It follows that frizzy hair must be considered a secondary character in man. No anthropoid or other ape has frizzy hair. Thus it must have been acquired at a later geological epoch, the straight or wavy hair being the primary character. Further, if it is a secondary character, it must be possible for it to have been acquired by the different races of which it is now a character at different times and in different ways. Frizzy hair, therefore, cannot be regarded as a possible basis for racial classification.

PREDICTIONS OF A MACKEREL FISHERY FROM SALINITY OBSERVATIONS.—In No. 8 *Medd. fra Komm. f. Havundersøg. Ser. Fiskeri*, Bind 7, 1925, Copenhagen, Dr. A. C. Johansen deals with the occurrence of mackerel in the Kattegat and adjacent parts of the Skagerak. In the waters of the Kattegat and Belt Sea, two layers occur usually, a surface layer of relatively low salinity, and a lower layer with relatively high salinity. This stratification is due in the main to the outflow of relatively fresh water from the Baltic, and the inflow of relatively salt water from the Skagerak. In the upper layer, to a depth of about 10 m. to 25 m., the resulting current is directed towards the Skagerak and the North Sea, while in the lower layer it is towards the Baltic. Johansen advances evidence to show that there is a connexion between yearly catches of mackerel in the Kattegat, a strong ingoing current in the lower layer in April and May indicated by a high salinity, and a low temperature of the surface waters in June. He concludes that a prediction with a certain degree of probability whether it will be a good or bad mackerel year can be given so soon as salinity observations in March and April are to hand, or about one or two months before the fishery in the Kattegat begins. Dr. Johansen adds a footnote to the effect that predictions will be published in *Dansk Fiskeritidende*.

ENCYSTMENT IN DIDINIUM.—C. Dale Beers records (*Proc. Nat. Acad. Sci. U.S.A.*, vol. 11, Sept. 1925) the results of studies on encystment in the ciliate *Didinium nasutum* with the view of ascertaining the cause of the conflicting conclusions reached by Calkins and by Mast. Calkins picked out from each of ten pure lines of this ciliate a single individual and supplied it with nine specimens of Paramæcium daily as food. As generations passed the fission-rate gradually decreased and the encystment rate increased, the latter reaching 100 per cent. in the 131st generation. Calkins concluded that in Didinium the passage of generations results in diminished vitality and ultimately in encystment with nuclear reorganisation and rejuvenescence, and that there are two types of encystment, one which protects against environmental adversity, and the other which occurs periodically and independently of the environment and results in rejuvenescence. Mast's experiments differed from those of Calkins in that at each isolation of Didinium, he placed with this ciliate enough Paramæcium to ensure a surplus of food, and he found no evidence to indicate that encystment occurs periodically. The present author has carried out two series of experiments on Didinium descended from one individual—one series of four lines was cultivated according to the procedure of Calkins, *i.e.* each Didinium was supplied daily with nine Paramæcia; the second series of four lines was supplied, as in Mast's investigations, with sufficient food to ensure a surplus. Except for this difference the two series were kept under the same conditions. The first series behaved like those in Calkins' experiments and the second like those of Mast. The encystment in the first series was due to the unfavourable condition—lack of food. The mere passage of generations does not result in encystment or in decreased fission-rate, provided the environment is favourable. The evidence indicates that all the cysts of Didinium are of one type—protection cysts.

EFFECT OF ULTRA-VIOLET RAYS ON THE GERMICIDAL ACTION OF THE BLOOD.—Colebrook, Hill, and Eidinow showed that when the skin is exposed to sources of ultra-violet rays the power of the blood to kill bacteria is greatly increased when tested *in vitro*—by so much as 65 per cent. in the rabbit and 17 per cent in man. Further work (A. Eidinow, *Brit. Journ. of Radiology* [B.I.R. Section], vol. 31, No. 306, 1926, p. 35) has shown that this increased germicidal power of the blood is evoked only when the rays produce erythema (reddening) of the skin—preferably a mild erythema that disappears within twenty-four hours. An excessive exposure of the skin to the sun's rays may cause a diminution of the bactericidal power of the blood. It is only ultra-violet rays shorter than 3100 Å U. which produce erythema and likewise increase bactericidal function of the blood, and those derived from the mercury vapour lamp, the carbon arc, and sun's rays are equally efficient. The mechanism of the action is uncertain, for there is no experimental evidence to support the view that the irradiated skin cells form a bactericidal substance If an animal is injected with bacteria so as to cause a septicæmia or blood-poisoning, the natural bactericidal power of the blood falls to a very low degree, and irradiation of the skin with ultra-violet rays during this stage does not increase the bactericidal power of the blood, so that acute infections of this kind cannot be treated by these means. Direct exposure *in vitro* of defibrinated blood to ultra-violet rays destroys such bactericidal power as it may possess, but injection of 10-20 cc. of this irradiated blood into a rabbit results in a marked rise in the bactericidal power of the blood of the animal after a latent period of two hours. The phenomenon appears to be due to some effect on the corpuscles, for it is not obtained with irradiated blood-serum without corpuscles.

A FLORA OF UTAH AND NEVADA.—Volume 25 of Contributions from the United States National Herbarium is a flora of Utah and Nevada, by Ivor Tidestrom. This area lies wholly within the arid region, but is very diversified in character with high mountains separated by dry desert valleys or by tablelands The flowering plants and ferns are treated systematically, some 3700 species being included, with keys to the species and larger groups. In an interesting introduction the author draws a striking parallel between topography and vegetation of this corner of the United States and the Iberian peninsula in Europe. H. L. Shantz gives a brief summary of the main characteristics of the chief plant communities from the point of view of the ecologist, whilst Arthur W. Sampson deals with the environment of the flora of the alpine regions and foothills Within this region the flora typical of the western United States meets the flora typical of northern Mexico, the line of demarcation being described by Tidestrom as conspicuous in south-western Utah and southern Nevada, where it coincides with the northern limit of *Covillia tridentata*, the creosote-bush.

TRAUMATROPIC CURVATURES IN PLANTS.—This conception of curvature in plants as resulting from the "stimulus" of a wound is perhaps of doubtful validity, and Adolph Beyer has recently completed an examination of the subject (*Biologisches Zentralblatt*, vol. 45, pt. 12), which leads him to an alternative interpretation Such curvatures, he thinks, should be explained as due rather to an interference with the normal nutritional correlation as a result of the wound. He thus explains curvatures in seedling hypocotyls, coleoptiles, and roots as due to a disturbance of one of two correlations, namely: (i.) Growth-promoting substances moving from the apex of the coleoptile, or the epicotyl in the case of the Helianthus seedling; (ii.) food supplies moving to growing tissue from regions of storage.

THE OLD RED SANDSTONE FLORA OF SCOTLAND.—Prof. W. H. Lang contributes an interesting paper to the *Transactions of the Royal Society of Edinburgh* (vol. 54, Pt. 2, No. 2), in which he continues the important studies which he commenced with the late Dr. R. Kidston. He has studied the plant-remains from the fish-beds of Cromarty and finds evidence of the existence of a considerable bulk of vegetation of varied character. By extracting the remains of spores and sporangia from the rock, he has recognised nine distinct types of spores and two types of sporangia. Some of the spores have a very characteristic form and ornamentation, but the plants which bore them are as yet unknown, and they indicate that several more plants of the epoch remain to be discovered. The other plant remains are fragmentary, but under Dr Lang's careful treatment have yielded valuable results. He has found that Thursophyton had circinate buds like Psilophyton. The genus Hostimella has received further elucidation, and two new species with characteristic sporangia have been described. One, *H. pinnata*, shows a series of incurved pinna-like branch systems with sporangia at their tips. No suggestion is as yet made as to the systematic position of these forms, but their remoteness from the Lycopodiales is pointed out. To a less cautious observer they suggest a resemblance to some of the much dissected fronds of the Lower Carboniferous pteridosperms and ferns. Another organism described, *Hostimella racemosa*, is a sporangium bearing branch system; it was derived from the Stromness beds. This is a remarkable structure consisting of an axis bearing sporangium-like organs on either side, each sporangium being surrounded by a zone where the rock is stained a darker colour forming a sort of halo. There is no evidence as to the type of plant on which these branches were borne and it is provisionally placed in the genus Hostimella, but it is clear that this artificial genus, while possessing little vegetative differentiation, had reproductive organs of a varied character. The whole work is a valuable contribution to our scanty knowledge of the earliest known land flora of the world.

MOUNTAIN BUILDING AND IGNEOUS ACTION.—In the *Proc. Am. Phil. Soc.* vol. 64, 1925, p. 283, Prof. R. A. Daly returns to his geological exploration of the possibilities arising from the assumption that the Taylor-Wegener hypothesis of continental drift is correct. He conceives that the moving continents slide on a substratum of hot basaltic glass which, though rigid to stresses of short periods, is extremely weak. Mountain chains are then explained as structures that have been compressed on the down-stream side of continental "landslides." Upstream, breaking tensions are necessarily developed, and mobile fractions of the substratum are forced up the abyssal fissures, the general type of magma generated being basaltic. Downstream, the granitic crust beneath a geosyncline is overridden by the sliding foreland, and part of it sinks down into the underlying basalt which is thus displaced, and tends to erupt along the soles of thrust-planes. The sunken crust then melts, and gives rise to secondary magmas that invade the crumpled sediments as batholiths and stocks with all their attendant dykes and lavas. The rise of magma is aided by gas pressure, the juvenile gases acting as fluxes in the development of volcanoes of the central type. A combination of the Joly and Wegener hypotheses may make this or some similar scheme workable, but it is difficult to believe in the glassy substratum, for seismology persistently fails to provide any evidence for the existence of a basaltic layer beneath the continents. A rock-layer of density about 3·4 is indicated, and this may be eclogite, since the geological evidence is conclusively in favour of a basaltic composition. The possibilities thus seem to be eclogite during periods of solidity and basaltic magma during epochs of fusion, basaltic glass being completely ruled out.

A Giant Crater in Alaska.—During recent exploration of the country west of the Aleutian Mts. by a United States geological survey party, a gigantic crater was discovered, which, with its associated features, closes what was supposed to be a wide gap in the volcanic line of the Alaska Peninsula. Mr. W. R. Smith gives an interesting account of the crater in Prof. Paper 132-J of the U.S. Geological Survey, 1925. The rim is nearly circular and has an average diameter of more than six miles. The area of the crater thus exceeds that of Crater Lake, Oregon (5¾ miles in diameter), but is only about half the area of the craters of Ngorongoro in East Africa and Aso-san in Japan. These three craters are all examples of the type known as calderas and are due to subsidence. The newly discovered crater, named Aniakchak Crater (after the river that rises within it), belongs, however, to the explosive type, of which it is now the largest example known, Katmai Crater, also in Alaska, having previously held the record with a diameter of three miles. If the volcano had originally possessed a low cone, then about 15 cubic miles of material must have been blown away. Much of this can be accounted for by the great spreads of volcanic ash already known to the east and south. Within the crater is a large truncated cinder-cone, rising to 2200 feet above Surprise Lake, which occupies part of the north-eastern floor of the crater. The volcanic formations lie on a basement of Upper Jurassic sediments, and the inner wall of the crater is made up of layers of pink and black lava—probably obsidian—with quartz-diorite below. Black obsidian is also found ten miles away, though exposures of lava flows are rare owing to the thick covering of the surrounding country by fragments of glassy lava, pumice, and ash. The volcano is now completely quiescent, no fumerolic activity having been detected.

Currents in the Upper Air.—The Meteorological Office, Air Ministry, in Professional Notes, No. 42 (London: H.M. Stationery Office, 1925, price 1*s.* 6*d.* net), gives the result of an "Investigation of the Winds in the Upper Air from Information regarding the Place of Fall of Pilot Balloons and the Distribution of Pressure," by Mr. J. Durward. This note discusses the horizontal movement of pilot balloons in relation to the distribution of pressure. The data used are obtained from post cards, on which the date, place, and time of origin are entered, attached to the pilot balloons. The finder of the balloon is requested to return the card after entering the place and time of finding. During 1923 more than 1000 cards were returned. The results throw some light on the direction of winds at high levels, but the method is attended by so many uncertainties that it is, on the whole, inferior to the careful observation of high clouds, although it is practicable in all weathers.

Variations in Radio Signals.—In broadcasting it is well known that there are great variations in the quality of the reception. These variations are due to many factors, including sunlight, temperature, barometric pressure, humidity and human agencies. As they occur not only from season to season, but even from hour to hour, they are far too complex to permit of a simple analysis. The only satisfactory method of attacking this problem is the statistical method, namely, to analyse similar observations taken over specified areas by a number of competent observers during a considerable period of time. A test of this nature was organised by the Bureau of Standards over a period of a year (1922–1923). Mr. C. M. Jansky has analysed the results in Paper No. 297 of the Bureau of Standards. The results shown by observations made of KDKA, the transmitting station of the Westinghouse Co. at Pittsburgh, prove that "fading" is most pronounced in September and October, and least in February and April. The atmospherics were worst in August and September, and least in February and March. It has sometimes been stated that signals from distant stations are often of greater intensity than signals from stations of similar power but situated much nearer to the observer. The results obtained by two entirely different sets of observers on two different transmitting stations verify this. It is clearly indicated that somewhere between 100 and 200 miles the signals are less satisfactory than the signals received from much more distant stations. From the scientific point of view this is of importance.

Structure of Graphite.—In No. 3 of the *Scientific Papers of the Institute of Physical and Chemical Research, Tokyo*, G. Asahara has shown by means of measurements of the diffraction of X-rays that, however finely powdered, graphite possesses a crystalline structure. In the case of thirty-four different forms examined, amorphous carbon and graphite are essentially identical.

Separation of Indium.—Reprint No. 5 from the *Scientific Papers of the Institute of Physical and Chemical Research, Tokyo*, is a description of the detection and separation of indium. A method was devised of precipitating indium by means of ammonium sulphide from a dilute solution acidified with sulphuric acid, after the addition of a small amount of tartaric acid and neutralisation with ammonia. This proved satisfactory when tested with mixtures of several kinds.

"Knock" in Internal Combustion Engines.—Report No. 979 (E. 15) of the Aeronautical Research Committee (London: H.M.S.O., price 2*s.* 6*d.* net) deals with closed vessel explosions of mixtures of air and liquid fuel (petrol, hexane, and benzene) over a wide range of mixture strength, initial temperature, and initial pressure. Attention was particularly directed to the production of detonation in internal combustion engines. The conclusions are too numerous to summarise, but a few points may be mentioned. At 100° C. the air-fuel ratio for maximum explosion pressure is considerably less than that required for complete combustion. Rich mixtures of all three fuels give rise to a knock, the intensity of which increases with decrease in the air-fuel ratio and is apparently preceded by high frequency vibrations. Raising the temperature sometimes eliminates the knock. With normal mixtures the explosion time diminishes with increase in initial temperature and increases with increase in charge-density. The addition of about 6 per cent. of exhaust gas to a normal air-hexane mixture has but little effect in suppressing knock at 230° C. initial temperature. Comparatively large percentages of water vapour can, apparently, be added to the charge without affecting appreciably the efficiency of the conversion of the chemical energy of the fuel into pressure energy, even when the explosion time is largely affected by these additions. The results connecting tendency to knock and the richness of the charge appear to contradict experience with actual engines. The report is fully illustrated.

The Carnegie Trust for the Universities of Scotland.

EVEN a cursory perusal of the twenty-fourth annual report of the Executive Committee of the Carnegie Trust leads to the conclusion that the beneficial influence exercised by the Trustees for nearly quarter of a century in furthering the cultivation of science in the Scottish universities shows no sign of abatement. Moreover, the financial support afforded by the Trust is not confined to the universities, but is now extended to a number of colleges and institutions which are more or less closely associated with the universities and are doing work of equivalent standard. About one-half of the income of the Trust is utilised partly in the endowment of research in all branches of science and partly in assisting the universities and other institutions to provide buildings and equipment for libraries and scientific laboratories, to endow professorships and lectureships, and to develop the social side of student life by the erection of unions and hostels.

As regards the first object, a sum of more than 18,000*l*. was expended in the academic year 1924–25 in the provision of teaching fellowships, the holders of which are expected to devote most of their time to research, research fellowships and scholarships, and research grants to members of the staffs and other investigators. Grants were also made to the Scottish Marine Biological Station at Millport, the Rowett Research Institute at Aberdeen, and the Animal Breeding Research Department at Edinburgh.

For the academic year 1925–26, 20 teaching fellows, 10 research fellows, and 31 research scholars have been appointed, while in addition, grants in aid of research have been given to 36 individuals. During the year 1924–25, 17 scientific papers were published by teaching fellows, 28 by research fellows and scholars, 27 by recipients of research grants, and 13 by investigators working in the laboratory of the Royal College of Physicians; in these papers the following subjects are represented: Mathematics, physics, chemistry, geology, botany, zoology, anatomy, palæontology, physiology, pathology, medicine. The judgments of the experts appointed by the Trust to report on the work of fellows and scholars are uniformly favourable, and it is recorded that many of those who in former years were thus assisted to pursue their scientific careers now occupy prominent positions in the academic or industrial world.

With respect to the provision of opportunities for the prosecution of scientific research in the Scottish universities, the operations of the Carnegie Trust have brought about a marked change for the better. Previous to Mr. Carnegie's munificent donation, there were very few post-graduate science scholarships, and many of the most promising students were compelled, by the necessity to earn a livelihood, to leave the universities as soon as they had graduated. Now a selected number of graduates are enabled to enter upon courses of research, vastly to their own advantage and to that of the universities. Moreover, as is evidenced by the following quotation from the report, the activities of the Trust have also benefited the universities in a less direct manner: ". . . it is evident that the cause of University education commands to-day the consistent confidence and support of private benefactors and of public bodies. On more than one occasion the Committee, in intimating their quinquennial grants, have expressed the hope that these would act as an incentive in stimulating local effort to supplement the Trust's contributions, and hasten the completion of many important purposes to which the Trust were able to give only partial assistance. It is gratifying to find that a large measure of help has been forthcoming. During the past Quinquennium alone private benefactions to the four Universities have exceeded 800,000*l*. Yet large as are the sums now devoted to University work in Scotland, there are few sections which do not call for some further advance, and the help which the Trust has been able to give is to be regarded as only an indication of the opportunities which still exist to benefit the people of Scotland through the Universities."

The Genetics of Cereals.

THE study of the cytology of cereals has come to have an important place in agricultural plant breeding. In both wheat and oats, diploid, tetraploid and hexaploid species are known, the haploid number of chromosomes being seven. In rye and barley the fundamental number is the same, but polyploid varieties have so far not been discovered. But as much less work has been done with the latter cereals, it is not improbable that polyploid species may yet be found in them. Dr. K. V. Stolze[1] has published a summary of our present knowledge on this subject, in which all the earlier work is reviewed.

In certain forms of wheat and oats eight pairs of chromosomes have been described. Some of these records may be due to error, but certain of them are probably correct. Stolze suggests that such forms, which are indistinguishable from the normal, have arisen through transverse segmentation of one chromosome. This is more probable than the alternative method of origin through non-disjunction as in *Œnothera lata*, since in the latter case external differences appear. But the author himself figures in rye a homotypic nucleus with six chromosomes, which is an indication that non-disjunction occurs in this species.

The author recognises that the determination of whether, in any case, a transverse or a longitudinal split has occurred, depends largely upon comparative measurements of chromosomes and nuclear volumes. The usual view has been that in the wheats the polyploid conditions have arisen through longitudinal splitting of the chromosomes, probably accompanied by crossing. Stolze favours the view that fragmentation of the chromosomes has been concerned. Further investigations alone can settle this question. It seems very probable that both longitudinal and transverse splitting of the chromosomes have occurred in different genera of plants, but in the wheats the view of multiplication by a transverse split encounters serious difficulties, both genetical and cytological. The determination of this point would throw further light on the relationships of the various forms.

A dwarf form of wheat, which originally appeared in experiments of de Vilmorin, has since been carefully studied by Messrs. Engledow and Wadham (*Journ. Genetics*, vol. 16, No. 1), with interesting and important results. It was known that the dwarfs gave rise to talls which bred true and dwarfs which continued to 'split' in a ratio which might be interpreted as 1 : 2 : 1, including certain bushy plants which never flowered. Also, the talls and dwarfs could not always be distinguished by their heights. It was found that in each generation dense-eared plants (a safer character to deal with than dwarfness) gave (1) lax-eared, (2) dense-eared, (3) short plants with one stem and no ear, and (4) bushy pigmy plants with no ear. The last, when grown under special conditions, produced ears which were found to be denser than the normal dense-eared form. Dense-eared plants showed wide fluctuation in height, which made classification on a height basis impracticable. Usually, height and ear-density are inherited independently and are hence presumably determined by different chromosomes. It is therefore suggested that in this ever-splitting race there may have been a fusion of these two chromosome pairs, this being a part at least of the mutational change to which the dwarf form owed its origin. A number of ever-splitting races of cereals are discussed. It is hoped that a cytological investigation of this peculiar dwarf will be made, which may help to clear up the genetic peculiarities of such ever-splitting races.

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[1] "Die Chromosomenzahlen der hauptsachlichsten Getreidearten nebst allgemeinen Betrachtungen uber Chromosomen, Chromosomenzahl und Chromosomengrosse im Pflanzenreich." Von Karl Viktor Stolze. (Bibliotheca Genetica, Band 8.) Pp. iii+71. (Leipzig: Gebruder Borntraeger, 1925.) 9.60 gold marks.

In another paper in *Journ. Genetics*, vol. 16, No. 1, Messrs. Engledow and Hutchinson give some results of crossing between *Triticum turgidum* and *T. durum* or rivet and Kubanka wheat. Since these are both tetraploid species, there is no sterility in the hybrids. The F_1 plants from this cross showed the vigour of heterozygosis. In previous experiments with wheat the endosperm characters of the seed have appeared to show maternal inheritance, in spite of the fact that double fertilisation takes place, which might be expected to lead to the phenomena of xenia, or paternal influence on the endosperm. In *T. turgidum* × *T. durum* the grains were larger than in either parent, but while intermediate in certain features, the vitreous texture and extreme hardness of the durum endosperm were dominant. Moreover, the grains on each F_1 were uniform, although the endosperm really belongs to an F_2 generation and might be expected to show recombinations. In the F_2 plants the same condition held, but in addition to the plants with endosperm like *turgidum* or like *durum*, there were other plants in which the grain showed various mixtures of the two kinds of tissue. The striking difference between the phenomena of xenia in maize endosperm and maternal inheritance in wheat endosperm leads to the suggestion that since in wheat seeds the endosperm cells are already dead, the paternal character determined by the male nuclei has not had a chance to express itself. But the same conditions would appear to obtain in the maize seed, where xenia occurs.

In these crosses the inheritance of solidness of straw has also been studied. The "lodging" of cereals is believed to be due to lack of elasticity, rather than lack of strength, in the stems. Solid straw has greater elasticity. In different varieties of wheat various kinds of solidness were found, and these were in general unifactorial differences; but the results were influenced by other factors for size of straw.

From these crosses it should be possible to produce a rivet wheat with high yield, hard, 'baking' endosperm, and solid, non-lodging straw.

R. RUGGLES GATES.

Dielectric Constant and Molecular Structure.[1]

THE physical methods for investigating the structure of molecules are principally five in number: (1) the ratio of the gaseous specific heats at constant pressure and constant volume; (2) the arrangement of atoms in crystals found by X-ray diffraction methods; (3) the molecular band spectra as interpreted by the quantum theory; (4) phenomena indicating strong fields of force around certain types of molecules; (5) refractivity and dielectric properties. The connexion between dielectric constant and molecular structure was to some extent realised by Faraday, but the theory has been developed by Lorentz, Debye, J. J. Thomson, Gans and Pauli. Recent tests have confirmed the basis of the theory.

The electrons in a molecule are displaced in an electric field, causing the appearance of an electric moment. Account must also be taken of the facts that not all electrons are similarly situated in the molecule and that an effect is produced on the field of its neighbours by the displacement of an electron. The effect produced on the displacement of any electron by that of other electrons in the same molecule must also be considered. If each molecule is a permanent electric doublet of moment μ, there is a tendency of molecules to orient themselves with their electric axes in the direction of the field. This is hindered by the thermal agitation and a statistical average degree of alignment results, depending on the moment of the doublet, the strength of the field and the temperature. All these factors are included in the equation of Debye:

$$\frac{\epsilon - 1}{\epsilon + 2} = 4\pi N\left(\frac{e^2}{3}\sum_{1}^{n} \nu_p r_p L_p + \frac{\mu^2}{9kT}\right) = \left(A + \frac{B}{T}\right)D.$$

In this ϵ is the dielectric constant; N the number of molecules per unit volume; e the electronic charge; ν_p the number of electrons of type p in the molecule; r the binding constant; L_p a factor to take account of the effect produced on the displacement of any electron by that of other electrons in the same molecule; k Boltzmann's gas constant; T the absolute temperature; A, B are constants, and D is the density.

In the case of gases the equation has only recently been tested with sufficient accuracy; ϵ is very near unity. One of the experimental methods, used by Herweg and improved by Zahn, consists in amplifying the electrical beats between two differently tuned oscillating circuits, one of which contains the experimental condenser alternately filled and emptied of gas. The electrical beats are made audible by a telephone receiver and produce acoustical beats with the sound from an electrically driven tuning-fork. This method is capable of measuring a change in capacity of one part in two millions. By plotting $(\epsilon - 1)vT$, where v is $1/D$, a straight line is obtained, from which A, the binding constant r and B, or the permanent electric moment μ of the molecule, may be computed. The values of μ so found vary from $1{\cdot}03 \times 10^{-18}$ for hydrogen chloride to $0{\cdot}06 \times 10^{-18}$ for carbon dioxide. In the case of liquids, the values vary from $0{\cdot}20 \times 10^{-18}$ for benzene to $2{\cdot}15 \times 10^{-18}$ for amyl alcohol; the value for water is $1{\cdot}98 \times 10^{-18}$. The application to liquids is not very good, probably on account of the mutual actions between molecules not allowed for in Debye's formula, and Gans has derived a much more complicated formula. C. P. Smyth has shown that it may be combined with the Lorentz dispersion formula to permit at least an *approximate* calculation of the electric moment in many cases. In some cases the moment varies with temperature, apparently due to association.

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[1] Abstract of an address by Prof. K. T. Compton, of Princeton University, retiring vice-president of Section B (Physics) of the American Association for the Advancement of Science, delivered at the Kansas City meeting on December 30, 1925.

If assumptions are made as to the structure of molecular models, the consideration of dielectric constants will enable these to be tested, although of course it will not explicitly give us the structure of the molecule Prof. Compton gives examples of the Lewis-Langmuir type and shows that the electric moments produced by the shifts of the electrons in the formation of molecules are reasonable values.

The binding constant may also be calculated from refractivity data, and the figures derived by Born and Heisenberg, Fajans and Jooz, Smyth and others indicate that the electrons are most easily shifted in ions with small central positive charges (cores) and also in large atoms, where they are far removed from the centre. The deformability of molecules thus indicated has an important bearing on the theory of spectra, and a difficulty in the Ritz formula may perhaps be resolved if it is assumed that the electron shell is distorted by the field of the valency electron rotating about the core of the atom. Prof. Compton indicated that numerous interesting problems still await investigation in other aspects of dielectric constants.

University and Educational Intelligence.

ABERDEEN.—The Senatus has resolved to confer the honorary degree of LL.D. on Prof. F. W. Oliver, professor of botany in University College, London; Dr. R. W. Reid, emeritus professor of anatomy in the University of Aberdeen; Prof. T. B Wood, professor of agriculture in the University of Cambridge.

BIRMINGHAM.—The report of the Principal (Mr. C. Grant Robertson) presented to the annual meeting of the Court of Governors on February 25, shows that the number of students, which had been steadily diminishing since the abnormal period of inflation following the War, last year reached its minimum, and there are indications that recovery has already begun. The percentage of unmatriculated and part-time students continues to decrease.

The construction of the new block for the biological departments at Edgbaston is rapidly progressing, and it is expected that the building will be in use next session. The transfer of these departments, however, will raise a serious problem, in that the Harding Library in its present form will be quite inadequate to meet the consequent increase in the demands on its space.

The new building for the Department of Petroleum Mining is already occupied, and is shortly to be formally opened. In addition, a new laboratory has been erected for the Mining Department and equipped with large-scale experimental plant for the study of scientific and technical problems of coal treatment, the funds being provided by the Central Committee of the Miners' Welfare Fund. The Principal directs attention to the fact that the Mining Department now serves as the post-graduate mining school for the Universities of Oxford and Cambridge.

An appeal is made for more generous support of the University by the midland area generally. In particular, "What is needed to-day is the establishment, on an adequate scale, of post-graduate scholarships. Its absence is a cause of national waste; and no better service to the cause of true education and a heightened national efficiency could be rendered than by the creation of such an endowment."

CAMBRIDGE.—Mr. G. F. Shove, University lecturer in economics, has been elected to a fellowship at King's College. Mr. I. A. Richards and Mr. F. McD. C. Turner have been elected to fellowships at Magdalene College.

A slight change has been introduced into the regulations governing medical studies; it is now laid down that no student may attend any course of instruction for the third M.B. examination until he shall have passed the last part of the second examination (pharmacology and general pathology). Some 'young men in a hurry' may find this distasteful, but there is little doubt that the principle on which the change is founded is sound.

The Board of Research Studies is proposing that a summary of each successful thesis for a research degree shall be published in the *Reporter*. Such summaries would then be distributed to the universities from which non-graduate research students are drawn. The present practice is that dissertations are placed in the University Library; some of them never appear in print, and in this way good work is sometimes lost to sight and memory. It is thought that the present proposal would both obviate this possibility and also avoid overlapping in research work. Incidentally, the great increase in numbers of research students at Cambridge in recent years will become apparent.

The governing body of Emmanuel College is offering to a research student, commencing residence in October 1926, a studentship of the annual value of 150*l*. Preference will be given to a candidate who has already completed at least one but not more than two years of research. Applications should reach the Master of Emmanuel (The Master's Lodge, Emmanuel College, Cambridge, England) not later than June 30. Candidates should submit two certificates of good character, a statement of the proposed course of research, and evidence of general ability and of special fitness for the proposed course of research.

LONDON.—The offer of the Petrie Medal Committee, on behalf of the subscribers, of a Petrie Medal and Fund amounting to 75*l*. has been accepted. The Medal is to be awarded once in every three years for distinguished work in archæology, preferably to a British subject.

Prof. C. A. Lovatt Evans has been appointed as from Aug. 1 to the Jodrell chair of physiology tenable at University College. Since March 1922 Prof. Lovatt Evans has been University professor of physiology at St. Bartholomew's Hospital Medical College. During this period he has published "Recent Advances in Physiology" (1925) and edited a new edition of Bainbridge and Menzies' "Essentials of Physiology" (1925).

Dr. G. V. Anrep has been appointed as from March 1, 1926, to the University readership in physiology tenable at University College. Dr. Anrep was educated at the University of Dorpat and at the Medical Faculty of the University of Leningrad. From 1912–14 he was engaged in research work at the University of Leningrad and at University College, London. From 1917 until 1920 he was senior assistant in physiology at the Institute of Experimental Medicine of Leningrad and in 1920 he was appointed assistant, and in 1923 senior assistant in physiology at University College, London. He obtained the D.Sc. degree in physiology in 1923 and has been awarded the Schafer Prize and the Julius Mickle Fellowship (1924–25) for his research work in this University. His published work includes numerous articles in the *Journ. of Physiol.* (1912–25); *Proc. Roy. Soc.* (1923–25); and in *Heart*.

APPLICATIONS for the Beit fellowships for scientific research should be made upon a prescribed form and sent to reach the Rector, Imperial College of Science and Technology, South Kensington, S.W.7, by, at latest, April 19.

Contemporary Birthdays.

March 8, 1855. Prof. Karl E. Ritter von Goebel
March 8, 1859. Sir Robert Blair.
March 9, 1862. Sir Sidney F. Harmer, K.B.E., F.R.S.
March 10, 1858. Maj.-Gen. Sir R. Havelock Charles, G.C.V.O.
March 10, 1861. Sir Arthur E. Shipley, G.B.E., F.R.S.

Prof. KARL E. RITTER VON GOEBEL, LL.D. (St. Andrews), a foreign member of the Linnean Society, was born at Billigheim, Baden. He was educated at the universities of Tübingen, Wurzburg, and Strasbourg. Elected to the chair of botany at Strasbourg in 1881, he later occupied posts at Rostock and Marburg, down to the time when he became professor of botany at the University and director of the Royal Botanic Gardens, Munich. An authority on the mosses and liverworts (Bryophyta), some of his work has appeared in English under the titles, "Sketches of Plant Biology" (1889), "The Organography of Plants" (Oxford, 1905).

Sir ROBERT BLAIR, Education Officer of the London County Council from 1904–24, is a graduate of the University of Edinburgh. Early he had practical experience as a schoolmaster, afterwards engaging in new avenues of work as Chief Inspector, Technical Education, Ireland, 1901–4. In 1903 he was a member of the Mosely Education Commission to America. He was president of the Educational Science Section at the British Association meeting in 1920. Sir Robert has written informing papers on features of American education; on the relation of science to industry, and cognate subjects.

Sir SIDNEY HARMER, Director of the Natural History Departments, British Museum, was born at Norwich. Educated at University College, London, he graduated at King's College, Cambridge; afterwards he was Assistant Tutor there (1890–1908) and Superintendent of the University Museum of Zoology.

Sir HAVELOCK CHARLES, sergeant-surgeon to the King, is a Knight of Grace of the Order of St. John of Jerusalem. He was educated at Queen's College, Cork, Dublin, and at one or more foreign universities. He passed into the Indian Medical Service from Netley in 1882. Formerly professor of surgical and descriptive anatomy in the medical colleges at Lahore and Calcutta, he was also surgeon of the Mayo Hospital, Lahore. Sir Charles accompanied their Majesties the King and Queen to India, 1911–12. Formerly he was president of the Medical Board and Medical Adviser to the Secretary of State for India. An authority in tropical diseases, he was for some time Dean of the London School of Tropical Medicine.

Sir ARTHUR SHIPLEY, eminent as a zoologist, Master of Christ's College, Cambridge, since 1910, was educated at University College, London, and Christ's College. He was demonstrator of comparative anatomy in his university, 1885–94. From 1917–19 he was vice-chancellor of the University of Cambridge. In 1887 he was delegated by the Colonial Office to investigate a plant disease in the Bermudas. Translator of Weismann's work on heredity, he has been a voluminous writer in all branches of zoological science. Sir Arthur is chairman of council of the Marine Biological Association.

Societies and Academies.

LONDON.

Royal Society, February 25.—**O. R. Baldwin** and **G. B. Jeffery**: (1) The relativity theory of plane waves. Weyl showed that gravitational waves of small amplitude may be resolved into waves of three types—longitudinal-longitudinal (L-L), longitudinal-transverse (L-T), and transverse-transverse (T-T). Eddington showed that the only physically real waves are T-T waves, and identified a particular type of T-T wave, accompanied by an electromagnetic wave, with light. It appears that these waves are not purely periodic, but are accompanied by a cumulative change, which seems to indicate that plane light waves cannot be propagated indefinitely. Waves of *finite* amplitude are now discussed without approximation. Whether accompanied by electro-magnetic waves or not, L-L and L-T waves are fictitious, while T-T waves propagated with the velocity of light are physically real. The exact differential equation of light waves is obtained. Eddington's conclusion that plane light waves cannot be propagated without a cumulative change is confirmed by the more exact treatment. (2) Electronic orbits on the relativity theory. For an electron and nucleus attracting according to the law of the inverse square of the distance, either one can describe about the other a circular orbit of any radius, or, if on the balance there is a mutual repulsion, no circular orbits are possible. On the relativity theory the inverse square law is no longer accurately obeyed, and the circumstances in which a circular orbit can be described are less simple.—**Margaret Stimson** and **G. B. Jeffery**: The motion of two spheres in a viscous fluid. The stream function of the motion generated by two spheres moving with equal velocities in their line of centres is calculated. The fluid thrust on each of the spheres is calculated and numerical values are computed for the case of equal spheres.—**A. L. McAulay** and **F. P. Bowden**: Evidence for a film theory of hydrogen overpotential from surface tension measurements. In order that hydrogen may be liberated at the cathode a film of high surface tension must first be formed over the mercury. In a pure acid electrolyte the passage of extremely small quantities of electricity produces this film, which remains intact when the circuit passing the current is broken. Addition of small quantities of ions of metals more noble than copper destroys the film completely and instantly; metals less noble than copper leave the film intact. The film when fully formed seems to have a definite place in the electrochemical series. Production of overpotential at the cathode requires the initial establishment of the film. In building up the film, single electrode potential measured above reversible potential of mercury is proportional to surface tension of film; and finally, further addition to the film increases single electrode potential, but leaves surface tension approximately constant.—**J. H. Wolfenden**: Critical potentials of hydrogen in the presence of catalytic nickel and copper. By comparison with results obtained when molecular hydrogen was the preponderating source of ionisation, it is concluded that substantial quantities of atomic hydrogen are present at the metal surface. Similarity exists between the effect upon the form of the ionisation curve of the presence of the catalyst metal and that of an incandescent grid (as determined by Olmstead).—**J. P. McHutchison**: Adsorption experiments with radium D and radium E. An isotopic precipitate, formed under such conditions that one of the two analogous radio-active compounds is soluble, exhibits a preference for its own isotope, whereas a non-isotopic precipitate displays no such preference. The addition of a soluble lead salt to a solution of radium D and radium E stops the adsorption of radium D by charcoal, and in this way radium E has been extracted in a state of great purity. The half-life period of radium E has been so determined as 4·9 days.—**J. S. Dunn**: (1) High-temperature oxidation of metals. The oxidation of three copper-zinc alloys has been investigated. It is controlled by diffusion through a protective film of oxide, and the rate of oxidation varies exponentially with the temperature. The variation of diffusion rate with temperature is deduced. (2) The low-temperature oxidation of copper. Oxidation of copper in its normal commercial state follows the theoretical parabolic law over comparatively short time intervals. Oxidation of catalytically active copper proceeds more rapidly. The origin of this departure from the ideal law is traced to changes occurring in the oxide film, and a general parallel is established between catalytic behaviour and oxidation rate.—**J. Heyrovský**: A note on the significance of the electrode potential. The stages of the author's cycle, described by J. A. V. Butler as irreversible, involve the correct free energy terms.

Geological Society, February 3.—**S. James Shand**: The alkaline rocks and ring-intrusions of Pilansberg (Transvaal). Pilansberg, a group of hills in the western Transvaal, is the largest of the secondary eruptive complexes which are super-imposed upon the great complex of the Bushveld. The energy which caused the extrusion of the Bushveld felsites, and the intrusion of the sheets of norite and red granite, was not quite exhausted by these tremendous events; but reactions went on underground, which led to the opening of new channels through which alkaline magma ascended. Plugs and dykes of syenite and foyaite cut the granite and the norite in Sekukuniland, in the Pretoria district, and in the west, where Pilansberg presents one of the greatest intrusions of purely alkaline rocks in the world. The Berg is circular in outline, and covers about 200 square miles. The rocks may be grouped into (1) a volcanic series and (2) an intrusive series. The former includes felsites, phonolites, tinguaite, and a great development of tuff and breccia; these rocks formed a cover under which the intrusive series crystallised.

Linnean Society, February 4.—**A. Bruce Jackson**. On a new hybrid conifer (*Cupressus macrocarpa* × *nootkatensis*). The tree was raised in 1911 from seeds of a cone taken from a tree of *Cupressus macrocarpa*, growing about 50 yards from one of *C. nootkatensis*, which was evidently the pollinating plant.—**B. O. Coventry**: Coloured photographs of Cashmir plants. —**C. C. Hurst**: On the nature and origin of species in Rosa. The genus Rosa may be divided into two major groups: (1) Diploid, with 7 gametic chromosomes; (2) Polyploid, with multiples of 7. Diploids fall naturally into 5 discontinuous species which breed true to their structural characters, are intrafertile and intersterile. Polyploids (except a few duplicated cultivated forms) are composed of various combinations of characters and chromosomes of the 5 diploid species. Chromosomes of diploid and polyploid species may be frequently observed working in septets during mitosis and meiosis. This presents a new mode of heredity with non-Mendelian ratios, and offers a solution of the problem of the inheritance of acquired characters. Three diploid species which do not conform to the septet formulæ are classed as distinct genera; they may be relics of the Tertiary flora. The distribution of species coincides with accepted views of the arctic origin of the land flora of the northern hemisphere, and points to an origin by descent from an arctic decaploid species with 5 double septets of chromosomes and characters, generalised and adapted to variable conditions, which, by successive losses of whole septets, gave rise to the lower polyploid species and eventually to the five specialised diploid species. The original decaploid species would most probably arise by duplications of an ancient diploid species under luxuriant conditions. This would be followed, in secular time, by differentiation of the five double septets of chromosomes and characters by duplicational segregations and gene mutations. Evolution would be an alternating process, from diploid to polyploid species (*i.e.* creative) and from polyploid to diploid species (*i.e.* emergent), according to geological conditions.

Optical Society, February 11.—**W. M. Hampton**: The annealing and reannealing of glass. (iii.) The determination of annealing temperatures. The formulæ deduced in pts. i. and ii. are applied to the case of heating glass under constant gradient, and the temperature at which strain disappears is obtained, the effect of the known change in the coefficient of expansion on this temperature being discussed. (iv.) The annealing of glass at low temperatures. The annealing equation is considered from the point of view of dimensions.—**F. W. Preston**: The nature of the polishing operation. The evidence for the existence of a surface layer on polished glass differing from the underlying material and from the surface layers of ground, or fire-glazed glass, or crystalline surface layers in the case of quartz, is slight or negative. The polishing process may be one of ultramicroscopic abrasion complicated by the fact that the fissures produced by one grain of the abrasive lie in the territory of its neighbour, and that the abrading efforts of the several grains tend to neutralise one another.

DUBLIN.

Royal Irish Academy, January 25.—**H. Ryan** and **Amy Markey**: The action of nitric acid and of nitrogen peroxide on triphenylamine. Nitrogen peroxide converted triphenylamine (in solution) into a tetranitrotriphenylamine which did not melt below 280° C. Nitric acid at the ordinary temperature and at low concentrations in acetic acid or carbon tetrachloride solution converted triphenylamine into the same tetranitro derivative, and in addition to it a trinitro derivative melting at 219° C. and a hexanitro derivative melting at 272° C. were obtained. The nitrotriphenylamine melting at 139° C. previously obtained by Herz (*Ber. Chem. Ges.*, 18, p. 2157) was shown to be 4-nitrotriphenylamine by synthesis from 4-nitrodiphenylamine.—**H. Ryan** and **Mary Glynn**: The relative speeds of the removal of nitric acid from systems containing certain aromatic compounds. Equimolecular amounts of nitric acid and diphenylamine, diphenylnitrosamine, stilbene, phenylbenzyl ether, diphenyl ether, o-tolylurethane, diphenylurethane, and ethyl-o-tolylurethane respectively were allowed to interact at the same concentrations in carbon tetrachloride solution at 60° C. The speed of the removal of the nitric acid was greatest in the case of diphenylamine and diphenylnitrosamine. The initial speed in the case of stilbene was greater than that with phenylbenzyl ether. Diphenyl ether reacted less rapidly than phenylbenzyl ether but more rapidly than the urethanes.—**H. Ryan**, **D. T. Flood**, and **P. T. McNulty**: The nitric compounds of β-dinaphthylene oxide. β-dinaphthylene oxide, in carbon tetrachloride solution and at the ordinary temperature, was converted by nitric acid at low concentrations into mononitro-β-dinaphthylene oxide, melting at 185° C., which was previously obtained by Hodgkinson and Limpach (*J.C.S.*, 59, p. 1100), and a dinitro-β-dinaphthylene oxide melting at 318° C. The latter substance was also got by the action of nitrogen peroxide on β-dinaphthylene oxide in acetic acid solution, but in the absence of a solvent a tetranitro-β-dinaphthylene oxide decomposing about 320° C. was obtained. Another crystalline tetranitro-β-dinaphthylene oxide melting with decomposition at 342° C. was formed by treating the dinaphthylene oxide with fuming nitric acid

EDINBURGH.

Royal Society, February 8.—Henry **Briggs**: The Wheatstone bridge as the means of measuring linear and angular dimensions at a distance, and its application to borehole surveying. The paper consisted for the most part of a description of the author's borehole surveying instrument known as the "Clinophone." In this instrument, by means of liquid resistances held in shallow cups provided with electrodes, the principle of Wheatstone's bridge can be utilised in obtaining polar co-ordinates and in reading such co-ordinates at any distance. Thus a transmitter, placed in a borehole of any depth, automatically furnishes messages to a surface receiving station, from which the direction and amount of deviation from the perpendicular of the hole can be obtained.—E. T. **Whittaker**. On the adjustment of Sir J. J. Thomson's theory of light to the classical electromagnetic theory. In a recent paper Sir J. J. Thomson has suggested a corpuscular or quantum theory of light, in which the light is supposed to consist of closed circular tubes of electric force moving, with the velocity of light, at right angles to their planes, like vortex-rings. This theory is now brought within the compass of the classical Maxwell-Lorentz theory of the electromagnetic field. Thomson's theory is extended by adjoining to the Maxwell-Lorentz equations certain terms which represent a "magnetic current." Any theory of the type of Thomson's necessarily involves the introduction of these terms. A kind of "electric vortex-ring" is thus obtained and expressed analytically: such a structure would behave as a light quantum.

LEEDS.

Philosophical and Literary Society, January 27.—W. P. **Milne**: The ten nodes of the Hessian of the cubic surface.—S. **Brodetsky**: The equations of the gravitational field in orthogonal co-ordinates. The equations of the gravitational field in Einstein's theory, when put down in their general form in terms of tensors, have the disadvantage of not being immediately intelligible. On the other hand, if an attempt is made to write out the equations in explicit form, the result is too complicated for analytical use. The gravitational equations are now worked out in terms of orthogonal co-ordinates with no other restriction. The similarity with Lame's transformation of Laplace's equation is interesting and suggestive.—E. C. **Stoner**: The atomic moments of ferromagnetics. The magnetic moment per atom of ferromagnetic metals and alloys may be found from the variation in susceptibility with temperature above the Curie point, and from the saturation intensity of magnetisation at low temperatures. Interpreted on the basis of the quantum theory of atomic magnetism, the apparently discordant values deduced by the two methods are compatible with each other, and with the values found for paramagnetic ions in solid salts and solutions.—G. F. **Brett** and R. **Whiddington**: Note on the passage of electrons through small apertures. It has been found in agreement with previous workers that if electrons *in vacuo* are accelerated towards an anode furnished with a narrow and more or less central aperture, only a small fraction of those electrons which appear on the further side have energies corresponding to the full potential difference. When the magnetic spectrum is examined, there is not a continuous gradation of energies as hitherto supposed, but a many-lined or banded spectrum depending on the conditions of the experiment.—H. S. **Patterson** and B. **Whytlaw-Gray**: Photophoresis. Photophoresis is of very general occurrence; it varies from substance to substance, and the negative effect never occurs without the positive. In some substances the negative effect is very difficult to detect. The effect is most marked with highly absorbent bodies such as carbon and organic dyestuffs.—Mrs. M. S. **Burr**: Preliminary note on solvate formation. An equation has been deduced representing the solubility of 2 : 4-di-nitrotoluene in sulphuric acid-water mixtures of different concentrations between 84·5 per cent. and 95 per cent. acid. Similar equations appear to be valid for other nitro-compounds, and may be explained by supposing that the solute forms, with the better solvent, a continuous series of solvates in equilibrium with a certain amount of free solute. The application of the equation may be complicated by the formation of compounds between the two constituents of the solvent, although no great difficulty is experienced where the compound is sharply defined, as, for example, in sulphuric acid monohydrate.—Sylvia **Garstang** and W. **Garstang**: Preliminary note on the development of Botrylloides and its bearing on the ancestry of the Chordata. The inclusion (Tunicata) or exclusion (Amphioxus-Craniata) of the hypophysial region within the neural folds is compared with the continuity or discontinuity of the longitudinal ciliated bands of echinoderm larvæ. The evolution of Chordata is due to elaboration of the original larval organisation, and its partial (Tunicata) or complete (Amphioxus-Craniata) supersession of an original sessile adult condition (*i.e.* pædomorphosis).—D. **Greenwood** and W. H. **Pearsall**: Observations on geotropism. Earlier conclusions are confirmed that geotropic curvatures are associated with changes in the hydrogen-ion concentration of tissues during the period of curvature. In *Vicia faba* stems and roots, the convex flank is slightly more acid. The differences in *p*H value observed are sufficient to cause differences in volume on the convex and concave flanks and hence to account for the curvatures observed. The different behaviour of the stem and root is associated with observations on the *p*H value of the fluids exuded from stem and root—these being of low *p*H in the stem. It is also found that geotropic curvature is more rapid in plants grown in the light (as compared with those kept in the dark), and also in plants which have been exposed to coal-gas.

PARIS.

Academy of Sciences, January 25.—Léon **Guillet**: The properties of certain treated chrome-nickel steels. It is known that under certain conditions of heat treatment, some special steels, especially chrome-nickel steels, become very fragile, although their other mechanical properties remain practically unchanged. Details are given of experiments forming a systematic study of this phenomenon.—A. **Vayssière**: The systematic position of the genus Erato, a prosobranch gasteropod mollusc.—A. **Myller**: The wrapping of surfaces.—Arnaud **Denjoy**: The iteration of analytical functions —D. **Mordoukhay-Boltovskoy** . The generalisation of the theorem of Eisenstein indicated by Tchebychef.—René **Lagrange** : A class of conformal representations.— — **Kivélioviteh** : The calculation of the conditions of primary shock in the problem of three bodies.—V. **Fock** : The reduction of the plane problem of elasticity to an integral equation of Fredholm.—Bernard **Lyot** : The polarisation of the planet Venus. The explanation of the polarisations found for Venus would appear to depend on the properties of clouds formed of minute drops of water.—E **Darmois** and P. **Gabiano** : The polarimetric study of mineral and organic dimolybdomalates. An application of Oudemans' law. An extension of work already published on the dimolybdomalates of sodium and ammonium to other bases (lithium, potassium, aniline, barium, calcium, methylamine, etc). All these are characterised by the anion $4MoO_3,2C_4H_4O_5$ —V. **Posejpal** : Resonance absorption in the domain of the X-rays.—Jean **Gandillot** : The presence of a bed of coal in the metamorphic strata to the south of Limoges.—P. **Fallot** and R **Bataller** : The tectonic of the mountains between Montalban and the coast of the Province of Castellon (Spain).—L **Eblé** and J **Itié** : The values of the magnetic elements of the station of Val-Joyeux (Seine-et-Oise) on January 1, 1926.—L. **Blaringhem** : Methods and results in the formation of hybrids of flax.—Mlle. Laura **Kaufman** . The growth of the body and organs of the pigeon.—Lucien **Daniel** : The variations of inulin in the grafted Jerusalem artichoke.—F. **Granel** : The morphological and functional signification of the pseudobranchia of fishes.—Auguste **Lumière** : The invisibility of certain flocculates —Mme. **Phisalix** · The rabicidal power of the blood of the hedgehog.—H **Violle** . The antiseptic power of chloropicrin. Details of experiments proving the great antiseptic power of aqueous solutions of chloropicrin with various types of pathogenic organisms.

February 1.—H. **Deslandres** : The magnetic perturbation of January 26, 1926, at the Meudon Observatory. This magnetic storm was indicated on the recording instruments for about 15 hours, and at the same time an aurora borealis was visible. The state of the sky prevented simultaneous observations of the sunspots with the spectro-heliograph. Measurements of the intensity of wireless waves received from Rome and Bordeaux are made daily at the Observatory, and on this day it was noticed that the intensity of reception was greatly increased, those from Rome being about four times the average strength.—A. **Blondel** : The reversibility of frequency multipliers with iron cores.—V. **Grignard** and F **Chambret** · The ketonic splitting of the tertiary alcohols. The decomposition by distillation of tertiary alcohols into water and an unsaturated hydrocarbon is well known, but in a few cases a splitting into ketone and hydrocarbon has been observed. It has been found that under certain conditions, detailed in the paper, the dehydration can be suppressed and the formation of ketone increased.—M. Camille Matignon was elected a member of the section of Chemistry in succession to the late M. A. Haller.—Charles **Jordan** : New developments for the application of the theorem of Bernoulli —N. **Mandelbrojt** : Transcendant numbers and analytical functions.—Nikola **Obrechkoff** : The summation of divergent series and the analytical prolongation.—V **Nechville** : A new form of differential equations of the restricted elliptic problem.—Jean **Fallou** and A. **Mauduit** : The maintenance of a non-sinusoidal free oscillation by resonance of one of its harmonics.—Pierre **Thomas** and Mlle. Marie **Sibi** : Contribution to the study of the structure of jellies Details of the study of the behaviour of the gel formed by the dibenzoyl acetal of sorbite.—Etienne **Audibert** : The mechanism of the fusion of coal. A study of the effect of rate of heating on coke formation.—Louis **Grenet** : Quasi-limiting states in crystallised bodies —Ch. **Courtot** and Jan **Krolikowski** : A new preparation of α-indanone. This substance is obtained with yields of 90 to 95 per cent. by the oxidation of α-chlorindane with chromic acid. Crude indene, obtained by a careful rectification of phenolic oils from coal tar and subsequent removal of phenols by soda, can be converted into the chlorindane by hydrochloric acid.—**Pastureau** and Mlle. **Zamenhof** . The preparation of propylidene and isoamylidene acetone with intermediate production of the corresponding ketols. Propionic aldehyde and alcohol are condensed with aqueous soda in the presence of ether to the ketol $CH_3-CH_2-CH(OH)-CH_2-CO-CH_3$ and this is readily dehydrated by oxalic acid to the unsaturated ketone. Isoamylidene acetone is obtained by a similar reaction.—L **Royer** : The mutual orientations of crystals determined by the single coincidence of a plane link of the two species.—Ch. **Maurain** and L. **Eblé** : The magnetic storm of January 26, 1926. Details from the records of the magnetograph at the Val-Joyeux Observatory —Raymond **Chevallier** : Extinction of the magnetic perturbations at the periphery of Etna.—Jean **Dufay** Polarisation of the light from the nocturnal sky.—P. **Lavialle** : The polymorphism of the anthers in *Knautia arvensis* —Pierre **Lesage** : The carnosity of the cotyledons and the bushy form of the stem in *Lepidium sativum* acclimatised to salt water.—Francois **Pellegrin** : The affinities of the flora of the volcanic summits of Tibesti (Central Africa) —R. **Souèges** : Embryogeny of the Umbelliferæ : The development of the embryo in *Carum Carvi*.—Armand **Dehorne** : Cytological indices of the presence of cholesterol in the normal eye —J. **Wolff** : The presence in various fungi of an oxydase not previously described. In a certain number of fungi there exists an oxydase, accompanying laccase and tyrosinase but distinct from these two ferments, which has the property in the presence of oxygen of oxidising ferrous salts of organic acids to ferric salts. The name ferrase is proposed for the ferment.—G. **Leven** and Emile **Coudert** : New data on the pathogeny and therapeutics of incoercible vomiting in pregnancy.—Georges **Mouriquand** : Pellagra. Its experimental realisation.—L. **Auger** : The experimental realisation of vitular fever.

MELBOURNE

Royal Society of Victoria, December 10.—E. **Kidson**: The annual variation in the velocity of cirrus clouds over Melbourne. The velocities were deduced from nephoscope observations. The predominating westerly component has a marked minimum (16·5 m/s) in February, a second in May, then rises to a maximum (26·3 m/s) in November. The variation is of a similar type for the south component, but opposite for the north and east. There is close correlation for each component between the velocity and the frequency of observation. The resultant mean direction is approximately 270° from January to April, 280° from May to August, thence veering to 265° in December.—Gerald F. **Hill** : Australian termites (Isoptera). Notes on Stolotermes, Calotermes, and Coptotermes with descriptions of new species.—New or little-known fossils in the National Museum, Pt. **xxix**.—On some tertiary plant remains from Narracan, S. Gippsland. The flora described occurs in a comparatively thin seam on the Ten Mile Creek near Thorpdale, and is part of a thick bed of sandstone and quartzite underlying the older basalt. It is apparently older than that of the Morwell Coal, and of a kind that compares closely with Berwick in Gippsland, and even with Dalton near Gunning, New South Wales. The "Acer" earlier recorded from the Australian Tertiary undoubtedly belongs to Sterculia.—**A. J. Ewart** and **A. H. K. Petrie**: Contributions to the flora of Australia (xxxi). Noteworthy among the new genera and species from the Northern Territory are the genera Wycliffea and Sideria, the former of which belongs to the Caryophyllaceæ and shows a response to xerophilous conditions by complete cleistogamy, while the latter belongs to the Malvaceæ and shows remarkable reduction of the andrœcium.—**A. D. Hardy**: Delayed dehiscence affecting several species in the families Myrtaceæ, Proteaceæ, and Coniferæ. A hedge of *Hakea leucoptera*, twenty years old, has retained its earliest fruits unopened, and several young "Cypress pines" have withheld seed of six years of fruitings. In Callistemon and Melaleuca delay is habitual. Some hedge plants of *Cupressus macrocarpa* showed five years' reservation. In *Eucalyptus platypus* var. *acuminatus* specimens from one tree in various stages showed that in six years the inch-long umbel stalks became immersed in the stem or branches. *Protea mellifera* and *Isopogon ceratophyllus* retain indehiscent fruits in persistent heads.

ROME.

Royal Academy of the Lincei, December 1925.—**G. Bruni** and **A. Ferrari**: Solid solutions between compounds of elements of different valency. Anhydrous lithium and magnesium chlorides. When examined by the powder method, anhydrous magnesium chloride gives a photogram corresponding with a cubic lattice coincident with that of lithium chloride; the elementary cell contains two molecules of magnesium chloride or four molecules of lithium chloride. Since the magnesium salt is doubly refracting and uniaxial, it has a pseudo-cubic structure belonging to one of the tetragonal or hexagonal systems.—**F. Zambonini** and **R. G. Levi**: Isomorphism of molybdates of rare earth metals with those of calcium, strontium, barium and lead. In the isomorphous molybdates of the alkaline-earth and cerium group metals, the elementary solids are found to contain equivalent volumes of these compounds.—**E. Bompiani**: Construction of projective-differential invariants of a surface.—**Carlo Severini**: Convergence of the series of orthogonal functions.—**Beniamino Segre**: Quadratic complexes of straight lines of S_4.—**Giovanni Sansone**: Indeterminate equations of the unit of negative type in real quadratic bodies.—**Antonio Signorini**: Presso-flexion of masonry.—**Arnaldo Belluigi**: Somigliana's theory of seismic waves.—**G. Natta**: Crystalline structure of cadmium and nickel hydroxides. For these hydroxides, which crystallise in the rhombohedral system, the dimension of the cell has been verified by calculation of the density and the atomic arrangement controlled by calculation of the intensity, various values being ascribed to the parameters. Both hydroxides are analogous in structure to magnesium and manganese hydroxides.—**A. Terni** and **C. Padovani**: Action of sodium hypophosphite on stannic chloride. In dilute solution these compounds do not appear to interact, but at higher concentrations they yield a voluminous white precipitate of the formula, $SnCl_4$, $Sn(H_2PO_2)_4$, $3H_2O$.—**Nathan Shalem**: A new cenomanian fauna of Palestine.—**Virginia Gennaro**: Piedmontite in mica-schists in the Lanzo valleys (Piedmont Alps).—**G. Amantea** and **G. Martino**: Investigations on spermatic secretion (xvii). Fasting and testicular activity in the pigeon.—**Luigi De Caro**: Variations of the electrical resistance of the muscles.

VIENNA.

Academy of Sciences, December 17.—**M. Kohn** and **A. Segel**: Communications on bromo-phenols, (xix.). Brominated nitro- and dinitro-cresol.—**L. Schmid** and **B. Becker**: Condensation of 2-amino pyridine with thiophosgene, and condensation of 2-amino pyridine with aliphatic aldehydes.—**E. Schrödinger**: The relation of the four-colour to the three-colour theory.—**L. Waldmann**: Geological survey of the Moravian mountain foundations north of Sigmundsherberg.—**R. Andreasch**: Carbamide and guanidine derivatives of the sulpho fatty acids (iv).—**O. Abel**: An attempted solution of the Flysch problem. The Flysch sediments in the Alps and Carpathians are very uniform, poor in fossils, with unexplained traces of life and associated with petroleum, suggesting that the Flysch must be a shallow water deposit. The mangrove swamps of south Florida and of Cuba suggest that the Inoceramen strata of the Alps and Carpathians may have been laid down in a tidal mangrove girdle.—**H. Handel-Mazzetti**: New Chinese plants (xxxviii.), with index to species described during the year 1925.—**R. Schwinner**: Mountain land north-east of Graz.

Diary of Societies.

SATURDAY, MARCH 6.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A.M.—Sir William Milligan: Hæmorrhagic Types of Ear Disease occurring during Epidemics of Influenza.—H. G Batcourt: Gradenigo's Syndrome.—Dr. A. R. Friel: Demonstration of Experiments on Ion Action.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Rare Gases of the Atmosphere and their Importance in Atomic Theory (1).

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Annual Conversazione.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch) (at College of Technology, Manchester), at 4.—G. Mortimer: Aluminium Foundry Practice.

MONDAY, MARCH 8.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Miss N. B Eales: The Anatomy of the Head of a Fœtal African Elephant, *Elephas africanus* (*Loxodonta africana*).—Dr. C. M. Yonge: The Digestive Diverticula in the Lamellibranchia.—Prof. W. Peddie: Present Problems in Colour Vision: the Laws of Visual Fatigue, and of Resultant Sensation.—Dr F. A. E. Crew: Fertility in the Domestic Fowl.—Prof. H. W. Turnbull: The Invariant Theory of Forms in Six Variables relating to the Line Complex.—*Read by title only*:—Prof. P. Humbert: Some Hyperspace Harmonic Analysis Problems introducing Extensions of Mathieu's Equation.—W. Saddler: A Geometry associated with the Double Binary (2 2) Form.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: The Egg (4): The White.

INSTITUTION OF STRUCTURAL ENGINEERS (Students' Meeting) (at 2 Victoria Street), at 6.—H. J. Deane and others: Discussion.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Centre) (at Chamber of Commerce, Birmingham), at 7.—Mr. Topliss: The Metallurgist in Inspection and Design.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—F. Creedy and others: Discussion on A Recent Development in A.C. Apparatus.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—R. B. Matthews: Electro-Farming; or the Application of Electricity to Agriculture.

GLASGOW UNIVERSITY ALCHEMISTS' CLUB, at 7.30.—Annual General Meeting.

INSTITUTE OF METALS (Scottish Local Section) (Annual General Meeting) (at Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow), at 7.30.—W. R. Barclay: Nickel and its Alloys.

BRITISH PSYCHOLOGICAL SOCIETY (Education and Medical Sections) (at Royal Society of Medicine), at 8.—Drs. Cyril Burt, M. Hamblin Smith, W. Rees Thomas, F. C. Shrubsall, and A. F Tredgold: Symposium on The Definition and Diagnosis of Moral Imbecility.

SURVEYORS' INSTITUTION, at 8.—Discussion on papers by C. P. Sanger, Sir John Oakley, C. H. Bedells, F. W. Hunt, and H. E. Sherwin on The Various Statutes which comprise the New Law of Property.

MEDICAL SOCIETY OF LONDON, at 8.30.—Sir Thomas Horder, Dr. C E. Lakin, and others: Discussion on Obscure Pyrexia in Adults.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.

INSTITUTE OF CHEMISTRY (Manchester and District Section).—Dr M. Young: The Endocrine Glands.

TUESDAY, MARCH 9.

MANCHESTER GEOLOGICAL AND MINING SOCIETY, at 4.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, at 4.—Prof. G. Elliot Smith: Brains of Apes and Men (Wilde Memorial Lecture).

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. W. W. C. Topley: Experimental Epidemiology (Milroy Lectures) (3).

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Dr. A. Wade: The Search for Oil in Australia.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. F. P. Stowell: The Purification of Sea-Water by Storage.—Dr. F. B. Nopcsa: Heredity and Evolution.—Dr. W. C. Osman Hill: A Comparative Study of the Pancreas.—Isabella Gordon: Notes on a Number of Muriceid Genera (*Alcyonaria Gorgonaceae*) with Special Reference to Spiculation.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—E. A. Chattock: Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at North British Station Hotel, Edinburgh), at 7.—Prof. S. P. Smith: An All-Electric House.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—Annual General Meeting.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Burnley Section) (at Burnley Municipal College), at 7.15.—A. E. Wilson: The Usefulness of Wood Patterns mounted on Boards.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Broadgate Café, Coventry), at 7.30.—P. Brewster: The Preparation of Motor Cycles for Speed Events.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—D. J. Scourfield: A Microscopic Fossil Crustacean from the Rhynie Chert, Aberdeenshire.

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN, at 8.—Edmund White: British Pharmacy and its Relation to Continental Practice.

ROYAL SOCIETY OF MEDICINE (Surgery, Medicine, Electro-Therapeutics, and Therapeutics Sections), at 8.—Discussion on The Treatment of Exophthalmic Goitre (continued).

WEDNESDAY, MARCH 10.

INSTITUTE OF METALS (Annual General Meeting) (at Institution of Mechanical Engineers), at 10 A.M. and 2.—G. Mortimer: The Die-Casting of Aluminium Alloys—A Review of Current Methods.—S. L. Hoyt and T. R. Schermerhorn: The Hardness of Cold-Rolled Copper.—R. W. Bailey: Note on the Softening of Strain-Hardened Metals and its Relation to Creep.—W. Feitknecht: Crystal Growth in Recrystallised Cold-Worked Metals.—R. Genders: The Interpretation of the Macrostructure of Cast Metals.—W. L. Kent: The Brittle Ranges of Bronze.—D. Stockdale: The Copper-Rich Aluminium-Copper-Tin Alloys.

INSTITUTE OF HYGIENE, at 3.30.—Dr. C. E. Shelly: The Incidence of Infectious Diseases in Public Schools.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. J. E. Marr: The Pleistocene Deposits of the Lower Part of the Great Ouse Basin.—Sir T. W. Edgeworth David and Dr. W. G. Woolnough: Cretaceous Glaciation in Central Australia.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—R. B. Matthews: Electro-Farming; or the Application of Electricity to Agriculture.

INSTITUTE OF METALS (Swansea Local Section) (at University College, Swansea), at 7.15.—Discussion on Annealing.

RADIO SOCIETY OF GREAT BRITAIN (at Institution of Electrical Engineers), at 7.30.

ROYAL SOCIETY OF ARTS, at 8.—Dr. R. Thiessen: The Microstructure of Coal.

INSTITUTION OF CHEMICAL ENGINEERS (at Burlington House), at 8.—H. M. Dunkerley: Refrigeration in Chemical Manufacturing Processes.

ROYAL SOCIETY OF MEDICINE (Surgery, Medicine, Electro-Therapeutics, and Therapeutics Sections), at 8.—Discussion on The Treatment of Exophthalmic Goitre (continued).

EUGENICS EDUCATION SOCIETY (at Royal Society), at 8.30.—Dr. A. S. Parkes: Sterility and Vitamin Deficiency: a Review.

INSTITUTION OF STRUCTURAL ENGINEERS (Lancashire and Cheshire Branch).—R. Travers Morgan: Building Construction from a Surveyor's Point of View: a Survey of Regulations governing Buildings.

THURSDAY, MARCH 11.

INSTITUTE OF METALS (Extraordinary General Meeting and Adjourned General Meeting) (at Institution of Mechanical Engineers), at 10 A.M. and 2.—T. B. Crow: Some Experiments on the Soft-Soldering of Copper.—A. Glynne Lobley and D. Jepson: The Influence of Gases on Copper at High Temperatures. Part I.—A. J. Murphy: The Constitution of the Alloys of Silver and Tin.—W. Hume-Rothery: Researches on the Nature, Properties, and Conditions of Formation of Intermetallic Compounds, with Special Reference to Certain Compounds of Tin. Parts I.-V.—H. J. Tapsell and J. Bradley: The Mechanical Properties at High Temperatures of an Alloy of Nickel and Copper, with Special Reference to Creep.—B. S. Evans and H. F. Richards: Determination of Zinc Oxide in Brass.—Prof. C. O. Bannister: Note on the Corrosion of an Ancient Tin Specimen.—A. M. Portevin: Striation due to Working or to Corrosion in Microscopical Metallography. A Contribution to the Study of the Mode of Action of Etching Reagents.

ROYAL SOCIETY, at 4.30.—J. A. Campbell: The Effects of Ultra-Violet Radiation upon the Metabolism of Healthy Subjects.—E. Ponder: A Study of certain Forms of Inhibition and Acceleration of Hæmolysis.—Dr. S. B. Schryver and H. W. Buston: The Isolation of some Undescribed Products of Hydrolysis of Proteins.—*To be read in title only*: —A. W. Greenwood and Dr. F. A. E. Crew: Studies on the Relation of Gonadic Structure to Plumage Characterisation in the Domestic Fowl.—Prof. E. P. Cathcart and W. A. Burnett: The Influence of Muscle Work on Metabolism in varying Conditions of Diet.—E. Fischer: The Heat liberated by the Beating Heart.

ROYAL ANTHROPOLOGICAL INSTITUTE (Edinburgh and the Lothians Branch) (at Royal College of Surgeons, Edinburgh), at 5.—D. M. Greig: Prehistoric Trepanning.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—R. H. Fowler: Atom-Mechanics (Lecture).—W. Saddler: Apolar Triads on Cubic Curves.—J. H. Grace: (a) A Point in Enumerative Geometry; (b) The Four-square Theorem.—W. H. Baker: A Particular Cubo-cubic Cremona Transformation.—H. B. C. Darling: On the Sums of Divisors of Numbers (Moduli 3 and 6).—Prof. G. H. Hardy: A Theorem Concerning Harmonic Functions.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. B. Hart: The Development of Psycho-pathology and its Place in Medicine (Goulstonian Lectures) (1).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. C. D. Ellis: The Atom of Light and the Atom of Electricity (5).

ROYAL AERONAUTICAL SOCIETY (Students' Section), at 6.—Flying-Officer R. L. Ragg: Experimental Flying from the Pilot's Point of View.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (jointly with the Bristol Section of the Society) (at Bristol University), at 6.—A. Ogilvie: Sifting Plant.—T. J. Stevenson: Sifting Machinery and Processes.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—A. F. Stevenson: Cable Troubles.

OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—R. Kingslake: Application of the Hartmann Test to the Measurement of Oblique Aberrations.—W. G. Collins: Some Physical and Optical Characteristics of the Stylus-on-Celluloid Method of Recording.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre (Dublin)) (at Trinity College, Dublin), at 7.45.—Dr. J. F. Crowley: Recent Developments in the Production of Synthetic Ammonia.

ROYAL SOCIETY OF MEDICINE (Neurology Section) (at National Hospital for the Paralysed and Epileptic, Queen Square), at 8.

FRIDAY, MARCH 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.—P. ten Bruggencate: Note on the Problem of Cepheid-Variation.—S. D. Tscherny: Occultations of Stars and Planets by the Moon, observed at Kiew in the year 1925.—W. Eichelberger and A. Newton: The Orbit of Neptune's Satellite and the Pole of Neptune's Equator.—Dr. H. Spencer Jones: Note on the Secular Motion of the Pole.—Prof. R. A. Sampson: The Structure of the Solar Cluster.—M. C. Johnson: The Velocities of Ions under Radiation Pressure in a Stellar Atmosphere, and their Effect in the Ultra-Violet Continuous Spectrum.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section) (Clinical Meeting) (at Royal London Ophthalmic Hospital, City Road), at 5.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—E. M. Archer: Heat Losses from Vacuum Vessels.—Dr. A. H. Davis: A Ripple Tank for the Study of the Acoustics of Buildings.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Parts concerned in the Secretion and Absorption of Cerebrospinal Fluid.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (jointly with Institution of Electrical Engineers) (at Armstrong College), at 7.—R. W. Gregory: Paper.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—J. E. Hodgson: Whaling in the South (Lecture).

INSTITUTE OF METALS (Swansea Local Section) (at University College, Swansea), at 7.15.—Discussion on Annealing.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Swansea Technical College), at 7.30.—E. A. Tyler: Some Notes on Pure Chemicals: An Inquiry into the Purity of Available Supplies.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—F. E. Webb: Paint Spraying.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle-upon-Tyne), at 7.30.—E. J. Eyres: What is Sea Speed?

ROYAL SANITARY INSTITUTE (at Town Hall, Hastings), at 8.—Prof. H. R. Kenwood: A City of Health (Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir J. J. Thomson: Radiation from Electric Discharges.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE (at Royal Technical College, Glasgow).—J. Mitchell: Corrosion.

SATURDAY, MARCH 13.

ROYAL SANITARY INSTITUTE (at Town Hall, Hastings), at 10.30 A.M.—Dr. G. R. Bruce, Miss Hester Viney, Dr. J. Fenton, and others: Discussion on Mothercraft and Fathercraft.—J. Parkin, H. T. Taylor, and others: Discussion on The Effect of the Public Health Act of 1925 on the Work of Municipal Engineers and Sanitary Inspectors.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Rare Gases of the Atmosphere and their Importance in Atomic Theory (2).

SCOTTISH JUNIOR GAS ASSOCIATION (at Royal Technical College, Glasgow), at 7.—S. H. Hunter: Scientific Service.

BIOCHEMICAL SOCIETY (at University College).

PUBLIC LECTURES.

SATURDAY, MARCH 6.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Other World of the Ancient Egyptians.

MONDAY, MARCH 8.

UNIVERSITY OF LEEDS, at 5.15.—Prof. W. H. Lang: The Flora of the Devonian Period.

TUESDAY, MARCH 9.

UNIVERSITY COLLEGE, at 5.30.—Dr. C. U. Ariens Kappers: The Evolution of the Nervous System. (Succeeding Lectures on March 10, 11, and 12.)

WEDNESDAY, MARCH 10.

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. A. Radcliffe-Brown: The Study of Backward Peoples: its Method and Practical Value. (Succeeding Lectures on March 12 and 15.)

THURSDAY, MARCH 11.

ROYAL SOCIETY OF ARTS, at 8.—W. A. Harvey: Housing, Past, Present, and Future. Its Effect on the Health and Outlook of the People (Chadwick Lecture).

SATURDAY, MARCH 13.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. H. Graham Cannon: How Animals Feed and what they Eat.

SATURDAY, MARCH 13, 1926.

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British Science and Invention.

Of the importance of research to the electrical industry, or of the notable improvements in machines, appliances, and processes brought about in the industry by special investigation, there can be no question. The new types of electric lamps, which give far better light at a smaller cost than those they superseded, and the new forms of submarine cables enabling speeds of working to be increased three or four times, are but two familiar instances of the happy results of successful research. Formerly progress was achieved mainly by the discoveries of inquirers working single-handed, but nowadays we speak of team work and communal research. The simple apparatus of bygone days has given place to plant of an extensive and expensive character quite beyond the pocket of the ordinary individual, and because of this, the financial requirements of industrial research have to be seriously considered. The subject crops up at the meetings of every research association, and at the annual luncheon of the British Electrical and Allied Industries Research Association on February 12 provided the president, Mr. Ll. B. Atkinson, with a theme for his address.

The position of this particular Association, which was founded in 1920, is that though it is admitted it has done fine work with good results, yet the Department of Scientific and Industrial Research has had to announce that the grant to the Association for the next five years will be only half that given during 1920–25, while in 1930 it will be stopped altogether. Many of the leading technical journals have referred to this matter, and though it is generally regretted that the Department is withdrawing its support, yet there appears to be no doubt that the industry will rise to the occasion, find the whole of its own research fund, and probably benefit itself in so doing. The *Electrical Review* declares, "Research is no mere accomplishment, something merely ornamental; it is bedrock necessity," and "the partial withdrawal of Government aid must be accepted as a challenge to greater efforts." "Those who have saved large sums of money through the work of the Association know that it is so and ought to subscribe freely to its funds."

As to the position of the industry itself, it is a really active branch of engineering, and it has not had to go through the prolonged depression of many other branches. According to one return, the value of British electrical exports during 1925 exceeded those of both the United States and Germany, the figures for the three countries being: United Kingdom, 5,762,000*l.*; United States, 3,977,000*l.*; and Germany, 2,876,000*l.* From these figures it is evident that the withdrawal of the few thousands of pounds allocated to the Research Association by the Government can make no very appreciable difference to the volume of research if all in the industry are fully alive to the fact that research is a sound proposition commercially.

In the course of his presidential address at the luncheon at the Savoy Hotel, Mr. Atkinson referred to the lack of national interest and understanding of scientific matters, and towards the close of his remarks said: "Research Associations and research workers are not asking for charity; they are urging that the present squalid civilisation should be replaced, as it can be, by a far better one, if applied knowledge in every sphere is encouraged and developed; that instead of being a last charge upon the resources of the nation, research should be a first charge." In pressing his claims, Mr. Atkinson referred in eloquent words to the epoch-making discoveries and invention of British men of genius, and to Great Britain, "which in science has towered above all others." He remarked that "modern industrial and scientific knowledge is almost wholly the production of British effort." He mentioned the work of men such as Watt, Bessemer, Faraday, Davy, Kelvin, Lockyer, Newton, and Joule in glowing terms. Not only in practical mechanics, but also in mathematics, in chemistry and in physics, Britain had led the way. As to electricity, "the voltaic battery and the magnetic action of currents of electricity are not British discoveries, but that said we have finished," while "our fundamental discoveries have been carried forward and applied by hundreds of brilliant workers in all lands, but the claim that every great step forward in modern science is a British product cannot seriously be refuted."

No one of British birth fully aware of the achievements of the men of our race can fail to be proud of our record, but whether we are justified in regarding ourselves as the fount and origin of these things to the extent implied by Mr. Atkinson may be doubted, and some of his statements would, we think, be difficult to substantiate before an impartial tribunal. If one speaks of Dalton and Davy, it is not right to forget Lavoisier. If Perkins laid the foundation of the coal-tar colour industry, it is well to remember he gained instruction and inspiration at the hands of Hofmann, to whom English chemists owe a great debt. At one time British students eagerly sought the laboratories of Magnus and Bunsen and Liebig. What sort of history of physical science could be written without a mention of Kepler, Galileo, Huygens, Leibnitz, Euler, Lagrange, Fresnel, Fourier, Regnault, and Helmholtz?

Though we are aware of the brilliant work of Englishmen in many fields of discovery, we should be surprised to find a foreigner who would assent to Mr. Atkinson's estimate. Neither barometer, telescope, thermometer, microscope, air-pump, Leyden jar, thermopile accumulator, phonograph, or gramophone can be claimed for Britain. If we have had our Arkwrights and Cromptons, others also have had their Vaucansons and Jacquards. In practical chemistry the French can claim Berthollet and Leblanc, the Belgians Solvay, and the Germans Achard, Wöhler, and Welsbach. Our title to the steam engine and locomotive and the fundamental processes in iron and steel manufacture cannot be disputed, but once launched upon industrial development, the United States in some ways surpassed the mother country. In a well-written and balanced "Popular History of American Invention," which appeared a short time ago, the writers had evidently been to some pains to give honour to whom honour was due, but just as Mr. Atkinson claimed the carbon incandescent lamp for Swan and failed to mention Edison, so the American writer gave the credit to Edison and omitted to mention Swan!

There have been many causes contributing to British eminence in the worlds of science and engineering. Great Britain was never cursed by such a disaster as the Thirty Years' War, neither were the industries of the country subject to the grievous taxation due to the extravagances of a Louis XIV. The success of British arms and the spread of British commerce both influenced national development, while with its freer political institutions Britain has from time to time been the asylum of many able foreigners who have added their quota to the common stock of knowledge. Of these the great Herschel is the outstanding example, but other names, such as Mond, Siemens, Dollond, De Moivre, and Sprengel will be recalled. It is most desirable that, if lessons from history are to be used to stimulate inquiry, the historical views should be broad and just, for, as Davy remarked when presenting the Copley medal to Arago, "Science like Nature, to which it belongs, is neither limited by time or space. It belongs to the world and is of no country and no age." The British share in the spread of natural knowledge was admirably set out in "Britain's Heritage of Science" by two distinguished men of science, but that review does nothing to detract from von Zittel's remark that "all civilised nations have shared in the development of the natural sciences, the history of any one of which must be to a certain extent the history of a scientific freemasonry." While this is true enough, Mr. Atkinson was perfectly correct in showing that British achievements in pure and applied science have had world-wide influence in modern civilisation, and his address should serve a useful purpose in enlightening the public as to the fertility and power of British scientific genius and purposeful invention.

Simple Natural History.

(1) *The Life Story of a Badger.* By J. C. Tregarthen. Pp. xvi+152+8 plates. (London: John Murray, 1925.) 6*s.* net.

(2) *Round about Sussex Downs.* By Frederick F. Wood. Pp. 222+8 plates. (London: Gerald Duckworth and Co., Ltd., 1925.) 7*s.* 6*d.* net.

(3) *The Natural History of Hertfordshire.* By Dr. A. Wilmore, Albert N. Wilmore, W. Graveson, Richard Morse and W. Bickerton. Pp. viii+152+16 plates. (London: G. Bell and Sons, Ltd., 1925.) 2*s.* 6*d.*

(4) *More Chats on British Mammals: Rodents and Bats.* By Dr. J. J. Simpson. Pp. 125+4 plates. (London: The Sheldon Press; New York and Toronto: The Macmillan Co., 1925.) 2*s.* 6*d.* net.

(5) *The Unity of Life: a Book of Nature Study for Parents and Teachers.* By H. R. Royston. Pp. 281+16 plates. (London, Calcutta and Sydney: George G. Harrap and Co., Ltd., 1925.) 7*s.* 6*d.* net.

THE natural history of these small volumes is simple in the sense that it tends to confine itself to observations of first degree, and to avoid the more difficult ways of biological truth. This simplicity almost implies that its descriptions are of a kind made by many earlier observers, even where they have not been compiled from already existing sources of information. There is here, then, little that can be called new knowledge, but there is a great deal that is of interest to the general reader with a leaning towards natural history, and for such the books are intended. In their diversity they illustrate a noteworthy characteristic of natural science, the variety of avenues by which the subject may be approached; for although each is typical of a distinct class of treatment, any one might be taken as an easy introduction to the study of natural history.

Mr. Tregarthen's work (1) is an excellent example of the individual life-history. He traces with vividness and insight the adventures of one of the most interesting survivors of the old carnivore fauna of Britain, which he classifies in his own way—"scientists tell us that the badger belongs to the weasel tribe; to me, however, who am concerned more with its habits than its anatomy, it is a bear." In the course of his descriptions he brings out two very striking facts: the abundance of badgers in the Cornish district with which he is familiar—twenty-six earths from St. Ives to Land's End, averaging about one to every mile of coast, and eighty-one earths inland—and the extraordinary extent and ramifications of some of the century-old earths (one with forty-five holes), where many pairs of badgers repose in amicable security. It is gratifying to find that an English naturalist can avoid the tendency to a misleading anthropomorphism, which characterises a school (peculiarly American) of simple natural history, without sacrificing a whit of the interest of his story.

The nature essay is represented by (2). A series of disconnected chapters, with a geographical link, gathers up odds and ends of information which appeals to the lover of the country-side. The essays, which range from old country sayings to butterflies, bird life, foxes, dogs, hunting, coursing, etc., reveal great enthusiasm and close observation. Particularly interesting are the short chapters on tracks and tracking, and on the ingenuity displayed by hares in misleading hounds upon their scent.

A much more comprehensive treatise is the county natural history of Dr. Wilmore and his colleagues (3), in which are given simple accounts, adapted for school use, of the geology, physical geography, plant and animal life of Hertfordshire. Appendices to the sections suggest many promising experiments and exercises for the use of teachers and their pupils. The authors have wisely adopted a regional grouping of their information, for this affords an easy approach to the discussion of adaptation in both physical and biological spheres. The treatment in the latter sections, however, is unequal, and where 21 pages have been given over to mammals and 38 to birds, it is scarcely sufficient merely to mention that fishes, insects, and other invertebrates exist. The latter groups are not only of supreme importance to man, but they also form essential links in the chain of existence.

Dr. Simpson continues the systematic survey of British mammals (4), of which he has already issued one small volume. The present series of "ten-minute" broadcast "chats" contains concise yet well-balanced and wonderfully complete accounts of the appearance and habits of almost all the described species of British rodents and bats, special attention being directed to their human interest. The adoption of Latin systematic names as chapter headings is unnecessary, and must be repellent to many of the ordinary English readers for whom the book is intended.

Of our five types, "The Unity of Life" (5) is the most ambitious, for it essays to cover the field of general biology with a variety of purposes. It aims at assisting parents and teachers in imparting a systematic knowledge of nature-study, at educating the general reader who is interested in evolutionary biology, at instructing the elementary biologist in the wider principles of his science, and running throughout is the desire "to help all who are brought into close association with children to impart naturally and easily a knowledge of the main facts of the reproduction of life." The author finds it difficult to keep his balance upon these many stools. The foundation of his work is laid on a modified type system, for he discusses in detail the relationships of a few selected examples, and here his descriptions are all that is required. But the foundation is too narrow to bear the superstructure of biological principles which he would erect upon it, with the result that the treatment of the wider aspects is sketchy and incomplete. The book will probably appeal most to teachers of school biology who wish to make plain the vital connexion between the botanical and zoological sides of their nature-study.

Physiology for Clinicians and Students.

(1) *Clinical Biochemistry.* By Dr. Ivan Maxwell. Pp. 124 (interleaved). (Melbourne: W. Ramsay, 1925.) 12*s.* 6*d.*

(2) *An Intermediate Text-book of Physiological Chemistry: with Experiments.* By Prof. C. J. V. Pettibone. Third edition. Pp. 404. (London: Henry Kimpton, 1925.) 15*s.* net.

(3) *Bainbridge and Menzies Essentials of Physiology.* Fifth edition, edited and revised by Prof. C. Lovatt Evans. Pp. viii + 508. (London: Longmans, Green and Co., 1925.) 14*s.* net.

PERHAPS the most striking development of physiological knowledge in recent years has been on the chemical side, which has been due to a great extent to new and more accurate methods of analysis. Mention need only be made of the advance in knowledge of the oxidative process in muscle, of basal metabolism, of hæmoglobin, and of the ductless glands. It is important that this knowledge should be made available for the clinician as soon as possible. The clinician, however, cannot be expected to apply to his problems the elaborate methods which are necessary for scientific research, unless he can appeal to some-one with the necessary skill in a well-equipped laboratory. But since the chemical changes occurring in disease are often well-marked, methods which require but little apparatus or time for execution are sufficiently accurate to afford valuable information.

(1) The application of such methods to clinical work is well carried out in Dr. Ivan Maxwell's "Clinical Biochemistry." He has selected his methods with good judgment and has wisely refrained from making his book too large. Moreover, the book is not a mere reiteration of methods of analysis, for it is made interesting by some information about the diseases which lead to abnormalities in the blood and in the various secretions. The opening chapter on the urine is very well done, and is followed by an account of the estimations which can be made of renal efficiency. In this connexion we miss figures of urinary casts, glucosazone crystals, and of certain apparatus—in fact there are no diagrams at all. The book, however, is interleaved with blank sheets for the student to make his own drawings, and we think this is right. The chapter devoted to glycosuria is good, but might have been fuller with advantage, especially with regard to insulin. The estimations to be made in acidosis are well dealt with. There are welcome chapters on pancreatic efficiency and on hepatic efficiency, the van der Bergh's jaundice tests being given. There is also a very good account of gastric analysis—urinary sediments, calculi, variations in blood corpuscles and in hæmoglobin are all dealt with. The book can be safely recommended not only to the medical student but also to the clinician. A few slips have been left which would have been avoided by a careful revision of the proofs.

(2) Prof. Pettibone's text-book is a work of a very different character. It is divided into two parts, physiological chemistry and laboratory work. The latter part is the better, but some of the methods of analysis given are too elaborate for the clinician. The best chapters are those which deal with the proteins, the carbohydrates, the urine, and with blood analysis by Folia's well-known methods. The accounts of gastric and pancreatic digestion are scarcely adequate, for but little is given of the methods of testing gastric and pancreatic activity. The first part of the book is not well constructed; parts of it are quite elementary while other parts are highly technical and difficult. It must, however, be borne in mind that it is not easy to write a text-book on physiological chemistry, because it is almost impossible to say what processes are not chemical in the phenomena of life.

The book opens with a chapter on physical chemistry, with an account of hydrogen ion concentration and of colloidal solutions, and then deals with the chemical properties of the various substances connected with the animal body. All this is well done. The author then gives an account of digestion, bringing in scraps of knowledge about the processes of secretion and absorption, which are inadequate and some of them loose and inaccurate. It would have been better if these bits of physiological knowledge jumbled up with purely chemical matters had been omitted. There is a good chapter on protein metabolism, with an excellent account of the experiments initiated by Horace Fletcher, who, with his son-in-law, Dr. Van Sommeren of Venice, practised the chewing craze with such good results that several physiologists, notably Chittenden, investigated the effects of the low protein diet which the chewing leads to. Basal metabolism and vitamins, among other matters, are well dealt with, but this cannot be said of the treatment of the endocrine glands. The book will not seriously compete with those already published in Great Britain.

(3) It is gratifying to know that the editing of Bainbridge and Menzies' well-known text-book on physiology has fallen into the able hands of Dr. Lovatt Evans. This book has long supplied enough sound physiology for the unambitious medical student who has not the time or the ability to read one of the larger text-books. It is a pity that it has not been purged of some of its truly dreadful diagrams, such as that of the tracts in the spinal cord. Several other diagrams in the chapters on the nervous system are crude and inaccurate; Fig. 36, for example, is quite wrong and does not agree with the description in the text. The drawings of real structures, however, are clear and good, and several new ones have been introduced. It is difficult to decide how much histology should be introduced into a book of this kind. Yet Ranvier's drawings of degeneration and regeneration of nerve fibres are put in, without any drawings of normal nerve fibres. It would be impossible to point out the many little additions which have been made, but a notable one is the account of the work of Sir Gowland Hopkins and his school on tissue oxidations. The book has grown a little—it will defeat its purpose if it grows much more.

L. E. S.

Chemistry and Atomic Structure.

Chemistry and Atomic Structure. By Dr. J. D. Main Smith. Pp. 221. (London: Ernest Benn, Ltd., 1924.) 12*s.* 6*d.* net.

TO the author of this book belongs the credit of having been the first to suggest what appears to be the correct modification of the scheme originally proposed by Bohr for the distribution of electrons among the different levels and sub-levels in the atom. For example, in the completed *M*-level, according to this modification, in place of the 6.6.6-grouping of Bohr's original scheme, a 2.2.4.4.6-grouping is to be assumed. The probable correctness of this view is indicated by physical evidence, but the original presentation of it by the author was made in connexion with chemical considerations. A full statement of his evidence and reasoning, such as might be expected in this book, would therefore be exceedingly valuable, for it would be of the greatest interest to know whether the effects of differences in the electronic sub-grouping can be recognised in the chemical properties of the elements.

The first half of the book consists of an account of the development of the atomic and molecular theory from the speculations of Hindu and Greek philosophers to modern structural and stereo-chemical theories and the co-ordination theory of Werner; the second half gives an outline of some of the principal branches of atomic physics. It is in the last chapter that the deduction of the atomic structure of the elements from their chemical properties is considered, but the manner in which the evidence is presented is disappointing. It is difficult to gather from the statement there given a clear idea of what precisely the method is which has enabled the author to deduce the sub-grouping of the electrons from chemical facts. To take an example, he says: "The detailed chemical evidence, by which it can be shown that the first two valency electrons are differentiated in energy or firmness of binding from the third and fourth electrons, and that both of these pairs are differentiated from the remaining valency electrons, is so vast that no more than a tithe of this evidence need be cited to prove the point," and this is then given in the form of a series of chemical statements. But these statements have no obvious bearing on the question at issue. Thus the first is: "Cupric salts yield characteristically insoluble and stable di-pyridino-compounds." A careful explanation would be needed to show how this fact can be interpreted so that it can be brought into relationship with the detailed structure of the uncombined copper atom, but no explanation is given either of this or of the statements which follow it.

The difficulties involved on the electron-sharing theory of chemical combination in combining the two hypotheses: (1) that the maximum number of shared electrons is eight, and (2), that a single chemical bond always consists of two shared electrons, are discussed. The conclusion is drawn that the second hypothesis is to be abandoned, and the view is advocated that atoms are frequently linked through a single shared electron. (The author has further developed this view in a recent paper in *Chemistry and Industry.*)

It is then suggested that easily hydrolysable bonds contain only one electron whatever the valency of the atoms concerned. This, however, at once raises difficulties which seem to have been overlooked. For example, if the readily hydrolysable chlorine atom in the acid chlorides is linked through a single-electron bond, how are the remaining bonds of the carbon atom of the $-CO.Cl$ group to be interpreted?

The mechanism of electron-sharing is considered in an appendix. The possibility that the sharing is effected through the revolution of the electron in an orbit which encircles both nuclei is discussed in a passage that contains several errors, though in fairness to the author it should be stated that in the views which he expresses he is, in the main, following Prof. Morgan. The passage contains the following statements:

(1) "Obviously as such orbits have two foci of attracting nuclear charges, electrons cannot describe elliptic orbits." But it is well known that the ellipse is a possible and stable orbit for a particle revolving about two fixed masses situated at the foci.

(2) "The sections of equipotential surfaces about two equal similar charges [are] Cassinian ovals." (This statement is attributed to Clerk Maxwell.) Cassinian ovals, as is correctly stated, are curves in which the *product* of the distances of a point on the curve from the two foci is constant. But sections of the equipotential surfaces would only have this form in a field where the force varied inversely as the *first* power of the distance (as in that due to two parallel, infinitely long, straight, similarly charged wires). In the case under consideration it is the *sum of the reciprocals* of the two distances which is constant.

(3) If such a curve "is an orbit of constant potential [it is] consequently, a possible Bohr orbit for an electron." This inference is, of course, entirely unjustified. The simplest considerations show that neither Cassinian ovals nor the true equipotential curves are possible forms for the orbits.

There are other similarly unsatisfactory excursions into pure physics, including a theory of the ether which is claimed to elucidate the exchange of energy between electrons and radiation and the non-emission of radiation by an electron revolving in a Bohr orbit, discussions of the loss of mass associated with the loss of energy of a system, and a proposal that the orbital precession of an electron in the neighbourhood of other electrons should be regarded as taking place at right angles to the radius vector and the direction of motion. The ideas put forward in these passages are not in harmony with the spirit of modern physics, and in the opinion of the reviewer the author would have been well advised to have omitted them.

The treatment of the more purely chemical subjects is much less open to objection—though Werner's co-ordination theory is very doubtfully simplified by its presentation in the form of nineteen generalisations, and a good deal of space is devoted to the mechanical task of enumerating the types of isomerism that could occur among the derivatives of elements of the co-ordination number six.

Although there is thus much in this book which cannot be passed over without criticism, there is also much that is of merit and can be read with interest provided that the reader is already familiar with the subject. It gives a useful survey of several branches of chemistry, and some of the matter is presented in ways that are to a certain extent unusual and may provoke thought.

Our Bookshelf.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland: a Record of the Work done in Science, Literature and Art during the Session 1924–1925 by numerous Societies and Government Institutions. Compiled from Official Sources. Forty-second Annual Issue. Pp. vii + 407. (London: Charles Griffin and Co., Ltd., 1925.) 15*s*. net.

It is a pleasure to be able again to extend a welcome to this valuable reference work. The issue before us, the forty-second, is about the same size as its predecessor, and its contents are arranged on the plan which has now become familiar: namely, the societies are grouped into fourteen main groups according to the subject of their activities, and under each group the London societies come first, followed by the provincial bodies, and finally those in Scotland and Ireland. Under each item are given details of the society's activities, publications, officers, address, and similar essential information. The word 'society' is interpreted very broadly, as the publishers are able to include Government institutions such as the Royal Observatory, Greenwich, the National Physical Laboratory, and so on, and in each case a brief but comprehensive account of the year's work and publications is given. It adds to the value of the work that the information given is compiled from data supplied by officers of the bodies concerned, and the fact that few entries are followed by the words "No Return" shows that these officers appreciate the labours of the publishers in the service of learning.

The proof of the value of an annual reference work such as this, however, is in the hands of those who are constantly using it, and we shall not be alone in affirming repeated indebtedness to its pages. For that reason, and to enhance its usefulness, we do not hesitate to refer to some omissions we have noted. The majority of the research associations are still omitted, and also we have found no reference to the Society for the Preservation of the Fauna of the Empire, the British Institute of Philosophical Studies, the Institution of Welding Engineers, or the newly-formed Electroplaters' and Depositors' Technical Society. Nevertheless, we have no doubt that a year hence the volume will show similar signs of honourable service to those which now mark earlier issues.

The Essentials of Mental Measurement. By Dr. William Brown and Prof. Godfrey H. Thomson. (The Cambridge Psychological Library.) Third edition. Pp. x + 224. (Cambridge: At the University Press, 1925.) 17*s*. 6*d*. net.

The latest edition of this book contains a new chapter dealing with the present position in the controversial question of the relation between general and special abilities. In many respects this is the most interesting chapter in the book. Following a critical survey of Prof. Spearman's two-factor theory, Prof. Thomson enunciates his well-known sampling theory of ability, and proceeds to show that the two theories are not mutually destructive, that, on the contrary, in certain circumstances the differences between them are not nearly so fundamental as might be thought. It will be a source of encouragement to the non-mathematical student of these problems to learn that, while there are still vital differences between the various views, there is a movement towards agreement. The results of present investigations which are expected to settle some outstanding differences will be awaited with interest.

Meanwhile, it is perhaps significant to note that in some quarters there is an increasing tendency to approach the question from other directions. One feels that the study, with the aid of elaborate mathematical devices, of data derived from comparatively crude experimentation, is useful only within certain limits. This is, to some extent, confirmed by the note of caution maintained by the authors in regard to conclusions to be derived from the statistical study of mental measurements, especially from correlation coefficients. In this connexion it would be useful if the note on Kelley's *coefficient of alienation* were further developed in a later edition. In the main, however, the book remains unaltered, and contains, besides a well-developed statement of Prof. Thomson's own views, sections on the psycho-physical methods and the theory of correlation. Some new footnotes bring the book up-to-date.

Aphrodite aculeata. By Mahalah G. C. Fordham. (Liverpool Marine Biology Committee Memoirs on Typical British Marine Plants and Animals, 27.) Pp. viii+96+10 plates. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1925.) 5*s*. net.

A SYSTEMATIC description is given of the external features of Aphrodite, of its respiration, and of the circulatory, digestive, muscular, excretory, reproductive, and nervous systems. The lobules of the 'cephalic nerve centre' (*i.e.* the cerebral ganglia) and the associated nerves are described in some detail, but there is no figure illustrating the external topography of the centre. A giant cell from the ventral nerve cord is figured without any comment as to whether any other giant cells occur and whether giant fibres are present. A short account of the structure of the eye might have been added. In our opinion, too much is made of small differences between the types of cells in the cæcal epithelium; there are said to be eleven types, but it would be difficult to justify more than half of them. We note that many of the papers cited under "Literature" are not referred to. We must enter a dissent against 'plexi' as the plural of 'plexus,' and 'nuchal' is better than 'nucal,' which is used in the work.

The eight plates contain a useful series of figures. The text-figure of a parapodium of Nereis was evidently intended to show the outlines of the setal sacs, for reference letters are given in the text below the figure, but the outlines have been omitted. An indication of the magnification of the setæ shown in text-fig. 3 would have been helpful.

The examination of the external features and internal anatomy of Aphrodite forms part of the second year course in many laboratories, and hitherto no comprehensive account has been available. Miss Fordham has put a good deal of work into the preparation of the memoir, which will serve as a helpful guide to the study of an interesting polychæt.

Recent Advances in Physiology. By Prof. C. Lovatt Evans. Pp. xi+364. (London: J. and A. Churchill, 1925.) 10*s*. 6*d*. net.

IN a book covering recent advances, it is interesting and important to observe how the space has been allotted between the different fields of work. In this case Prof. Lovatt Evans has made a dull beginning with 90 pages on blood. The work on muscle by A. V. Hill and Meyerhof has been given 80 pages; work on circulation rate (Barcroft, Douglas, Krogh) and Starling's heart-lung preparation, 40 pages; Hopkins and Warburg on tissue oxidations, 30 pages; Krogh and Dale on capillary circulation, 30 pages; Magnus on postural reflexes, 30 pages; Pavlov on conditioned reflexes, 30 pages; finally the cheaper sensations of the endocrine world have some 20 pages.

It will be clear that this small volume is astonishing in its scope, yet there is much evidence that the author has carefully digested his sources of information, so that the presentation is logical and interesting. Even amid the technicalities of the mechanics of muscular contraction, he writes in such a way as to make it comprehensible to the reader. The accounts of the work of Pavlov and Magnus are particularly valuable, as there is no other general account of these in English.

It is difficult to exaggerate the importance of a book of this type, if it is short and good, for it plays a considerable part in deciding the questions to be asked in honours examinations during most of the next decade. By its means the habitual examiners bring themselves up-to-date, and it soon is responsible for the subjects studied by the students. Prof. Lovatt Evans' book will play an extremely valuable part in this direction, and it is fortunate that Messrs. Churchill should have persuaded a scholar at once so fundamental and clear-headed to write it.

A Graduated Course in Strength and Elasticity of Materials. By Edward Percy Coston. (Broadway Engineering Handbooks, Vols. 37 and 38.) Vol. 1. Pp. xii+264. Vol. 2. Pp. xii+436. (London: Scott, Greenwood and Son, 1925.) 10*s*. 6*d*. net each.

THESE two volumes were left in MS. by the late E. P. Coston, of the Engineering Department of the University of Liverpool, and were prepared for publication by students and colleagues upon the staff. It was a work worth undertaking, for the two volumes reflect the thought and experience of a good teacher. Most treatments of strength of materials incline either to be a practical compendium of engineering data more or less critically connected, or a mathematical analysis of the elastic properties of simple geometrical forms more or less divorced from reality. Both these snares are here avoided. In preparing this book, the author had in mind the average engineering student and his growth in knowledge of the subject. The work is arranged so that the elementary part is covered in vol. 1, in which the simple theory is interwoven with a critical discussion of elastic data. Each part of vol. 1 is developed to a more advanced stage in vol. 2. Copious examples graduated in difficulty and many of them worked out in detail are a distinct asset to the work.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Motion of Radiating Masses and the Effect of Radiation Pressure.

THE equation of motion of a body which is losing mass by the emission of radiation is

$$m\frac{dv}{dt}=F, \quad . \quad . \quad . \quad . \quad (1)$$

where m is the momentary mass of the body and F the applied force. The simplest justification for this equation is found in the principle of relativity, which requires that v shall be constant when $F=0$.

In NATURE of February 27, p. 300, Sir Joseph Larmor suggests that considerations of inertia would seem to require the equation

$$\frac{d}{dt}(mv)=F, \quad . \quad . \quad . \quad . \quad (2)$$

and finds an apparent paradox in the incompatibility of this with my equation (1). The paradox disappears as soon as it is noticed that equation (2) ignores the momentum carried away by the shed mass. In time dt the momentum mv experiences a gain Fdt from the action of the force F, and a loss $-v\frac{dm}{dt}dt$ through the shedding of the mass $-\frac{dm}{dt}dt$. Thus

$$\frac{d}{dt}(mv)=F+v\frac{dm}{dt},$$

which is equivalent to my equation (1).

Either of these quite simple arguments appears to decide the question in favour of my equation (1), and this by a conclusive verdict, not the mere "adequate practical settlement" of Sir Joseph Larmor.

Sir Joseph further suggests that the aberration effect of radiation pressure may be of importance in the dynamics of binary systems. Calculation scarcely supports this view. In the average binary orbit the force exerted by radiation pressure is about 10^{-13} times that exerted by gravitation, and the tangential force is v/C times this, or say 10^{-19} times the force of gravitation. The cumulative effect of this force might become serious as the number of revolutions of the system approached 10^{19}, but binaries do not live long enough for this to happen, and the actual effect must be negligible.

Consequently I adhere to the solution I originally gave (*Monthly Notices*, November 1924 and October 1925) for the orbit of a radiating binary. The orbit is an ellipse, the shape of which undergoes no change but the dimensions of which steadily increase as the mass wastes away, the product of the mass and the diameter of the orbit remaining constant. For example, the sun's wastage of 250 million tons a minute to produce radiation must result in an expansion of the whole solar system; the diameter of the earth's orbit increases by two centimetres per annum, those of the other planets, comets, and meteorites expanding in exact proportion. If higher accuracy than this is called for, dynamical factors arising from tidal friction and elongation of mass seem likely to have more importance than pressure of radiation.

J. H. JEANS.

February 27

The Spectra of the Neutral Carbon Monoxide Molecule.

WE can now claim to have a fairly extensive knowledge of the radiation of the ionised carbon monoxide molecule CO^+. The three associated spectra, namely, Deslandres' first negative bands, the comet-tail bands, and the associated system (*vide Proc. Roy. Soc.*, A, vol 108, p 349) have been discussed by Prof. R. T. Birge and others, and in particular by Dr. Mulliken in an excellent comparative study with other typical one-valence electron emitters (*Phys. Rev*, ii. 26, p. 561).

With regard to the spectra of neutral CO, I have recently been investigating some carbon spectra, arranging them in series, and assigning vibrational quantum numbers, and the results of this are presented in the present communication. About the time I had discovered the relationships referred to below, I had a communication from Prof. Birge in which he informed me of the substance of some of his work (published since in NATURE of February 13, p. 229). As my own findings are related to those of Prof. Birge, I am able through his kindness to correlate some of these results with mine; and these, together with a discussion of their significance, are given in this letter.

In a paper entitled "The Effect of Neon on Certain Spectra" to be published shortly in the *Phil. Mag.*, Mr. Cameron has given the wave-lengths of a new band-spectrum associated with carbon, the conditions for the production of which seemed to be peculiarly favourable in high-pressure neon. The spectrum lies between about λ2100 and λ2600, and falls into three or four groups having about five bands in each. Each band, however, is complex, being composed of five distinct sub-heads, and resembling the complex bands of the third positive carbon system or the fourth positive nitrogen system. I have made a quantum analysis of the above system and give it below (where only the second member of the quintuple heads is recorded for simplicity, *vide* Table I.).

TABLE I.

n'/n''	0	1	2	3	4	5	6	7	8
0	..	Present	44,244	42,160	40,102	..	..	..	..
1	..	..	Present	43,875	41,809	39,770	..	..	..
2	..	..	..	Present	Obsc.	41,457	39,444	..	..
3	..	..	..	..	..	..	41,099	39,113	.
4	..	..	..	..	..	..	..	40,739	38,783

Even under the most favourable conditions the system is not very strong, and Mr. Cameron suggests that his errors of wave-length may perhaps be so much as 0·5 Ångström units. I find that the system can be represented by

$$\nu=K+(1728{\cdot}2\,n'-14{\cdot}6\,n'^2)-(2151{\cdot}7\,n''-12{\cdot}7\,n''^2),$$

where n' and n'' are initial and final quantum numbers, and K has the values 48534·3, 48496·5, 48478·2, 48461·0, and 48431·2.

Prof. Birge has informed me that the fourth positive carbon bands are completely represented by the formula

$$\nu=64721+(1499{\cdot}28\,n'-17{\cdot}24\,n'^2)$$
$$-(2147{\cdot}74\,n''-12{\cdot}703\,n''^2),$$

and that they are the 'resonance' band system of CO as shown by Leifson's absorption work in the extreme ultra-violet.

It is clear, therefore, that within the limits of experimental error Cameron's bands and the fourth positive carbon bands have the same final electronic state, which is the normal state of the carbon monoxide molecule.

Prof. Birge has informed me further that the Ångström bands are represented by

$$\nu=22162+(2158\,n'-76\,n'^2)-(1499{\cdot}28\,n''-17{\cdot}24\,n''^2),$$

so that we have the interesting relation that the final state of the Ångström band emitter coincides with the initial state of the fourth positive carbon emitter.

I have discovered an analogous relationship by a quantum analysis of the third positive carbon bands, namely, that the final state of the third positive band emitter is coincident with the initial state of the emitter of Cameron's bands. The available measurements of the third positive carbon system are not good, so that any formula representing them is necessarily very approximate. I have, however, calculated roughly

$$\nu = 35300 + (2258{\cdot}5\,n' - 48{\cdot}5\,n'^2) - (1728{\cdot}2\,n'' - 14{\cdot}6\,n''^2)$$

for purposes of the completion of Table II. The main series, which is $n' = 0$, $n'' = 0$ to 5, permits of no doubt whatever of the above identification of the initial electronic state of Cameron's bands and the final electronic state of the third positive system. The multiplet structure of the common vibration levels is very conclusive. The best values of the separations in wave-number units are:

Cameron's bands : 37·8, 18·3, 17·2, 29·8
Third pos. carbon : 36·4, 17·4, 17·8, 29·6.

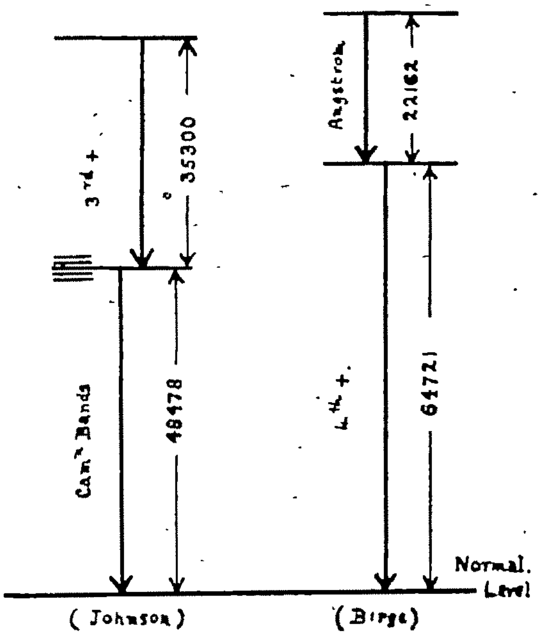

FIG. 1.—Energy levels of the neutral CO molecule.

This agreement is well within the limits of error. The relative intensities of the sub-heads correspond in both systems. It seems just possible that there may be six levels in reality, making the intervals in the case of the third positive system 8·8, 27·6, 17·4, 17·8, 29·6, but this head being fainter than the others would not be visible in the Cameron system. The question is important from the point of view of discussion of multiplicity in band spectra. It may be that the quintuplet is a characteristic of 2-valence electron emitters. We have the analogous fourth positive nitrogen structure in the case of N_2. With this in view I have examined Dr. Jevons's reproduction of the spectra of silicon oxide and aluminium chloride (*Proc. Roy. Soc.*, A, vol. 106, p. 174), which should present analogies, but I have not been able to arrive at any definite conclusion. The spectrum of silicon chloride shows doublet separation characteristic of the 1-valence type.

In view of Birge's work on the energy levels of the neutral nitrogen molecule (NATURE, November 1, 1924, and January 16, 1926), we now have the material for an interesting comparative study of two very similar molecules, CO and N_2. This, together with the above questions, is reserved for fuller discussion elsewhere.

Our knowledge of the neutral carbon monoxide molecule is summarised in the diagram, Fig. 1, and in Table II.

TABLE II.

Emitter.	*Spectrum.*	ν_e	*Excited State.*		*Normal State.*	
			(a')	(b')	(a'')	(b'')
CO	Cameron's	48,478	1728·2	14·6	2152·1	13·7
	3rd Pos.	35,300	2258·5	48·5 ?		
	4th Pos.	64,721	1499·28	17·24	2147·74	12·703
	Ångström	22,162	2158	76		

With regard to the possibility of identification of the initial levels of the third positive system and the Ångström bands, which are not very different, it does not seem possible to pronounce finally until more complete measures of the third positive bands are available. With regard to the latter, I have found that apparently the initial states $n' = 0$, 1, and 4 are present, while $n' = 2$ and 3 are absent (incidentally, this curious probability distribution in the various vibrational states is quite a common phenomenon). I intend to discuss this elsewhere. I am afraid the weight of evidence at present is against the identification of the above initial energy levels. The two values 10·34 volts and 10·73 volts may possibly be identified with the ionisation potential 10·1 volts (Foote and Mohler) of CO, but if so, this raises the identification difficulty.

With regard to Table II., I must be content merely to record the facts and discuss them fully elsewhere. As with 1-valence electron emitters, the greater stability of the second excitation level in comparison with the first may be noted.

Excepting the fourth positive bands, which must now be attributed definitely to CO, the surmises of a previous letter (NATURE, October 10, 1925) based on experimental evidence as to the CO origin of Cameron's bands, the Ångström bands, and the third positive bands are now seen to be confirmed.

Contrary to the views some have held, it seems doubtful if we can attribute *any* spectra to a carbon dioxide molecule. This would harmonise with its structure, which is of the 'inert gas type' and may not be expected to radiate (cf. BN). For similar reasons the silicon oxide and titanium oxide band spectra are probably due to SiO and TiO and not to SiO_2 and TiO_2. This may, therefore, have an important bearing from a thermo-chemical point of view on the temperature of the titanium oxide stars.

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The Constancy of Atomic Weights.

THE natural desire we have to attain finality in argument or experiment is usually helpful to progress but sometimes needs restraint. Believing such a need to exist in current thought upon the subject of this letter, we enter a plea for the retention of an open mind as to whether, in fact, elements as they naturally occur have always and everywhere the same atomic weight. The problem is evidently of fundamental importance, and its elucidation is likely to be hindered if chemists generally regard it as solved. We can the more easily ask for judgment to be reserved, as work done in these laboratories has provided the best evidence yet available for both constancy and variability in atomic weight.

Determinations of the ratio of boron trichloride to silver carried out by the writers in 1924 afforded purely chemical evidence that samples of boron from widely separated sources differed in atomic weight by about 0·02 unit (*Journ. Chem. Soc.*, 1925, 127, 696). Later determinations of the density of boric oxide from the same and other sources disclosed differences in density which in sign and magnitude confirmed the variations in atomic weight previously found (*ibid.*, 1926, 128). While we are unable to trace any flaw in this work, we have expressed our view that, in such a matter, it is unsafe to base conclusions on any one set of researches and that independent work is urgently needed.

At about the same time, Jäger and Dijkstra (*Versl. Akad. Amsterdam*, 1924, 33, 333; *Proc. Acad. Amsterdam*, 1924, 27, 393; *Zeit. anorg. Chem.*, 1925, 143, 233) seeking to ascertain, by purely physical means, whether or no the atomic weight of silicon were constant, prepared tetraethyl silicane from six terrestrial sources and six stony meteorites, compared the densities of the samples by a pyknometer method. They record in their paper the observed densities and the corresponding differences in the atomic weight of silicon. This method of stating the results may evidently give an erroneous impression of their precision, because Dr. Aston (Annual Reports on the Progress of Chemistry, 1924, 21, 243) was led to describe this as a "conclusive paper" affording evidence "that the ratio of the isotopes of silicon is constant within the limits of the highest accuracy attainable at present." We have, therefore, calculated the actual atomic weights of silicon corresponding with the observed densities, making the assumption, obviously reasonable and good enough for comparative purposes, that the mean observed density of tetraethyl silicane = 0·767349 corresponds with the most probable value of the atomic weight of silicon Si = 28·060. From these values it is at once apparent that the maximum and minimum values are 28·051 and 28·060, with a difference of 1 part in 1477. When we remember that many atomic weights have an uncertainty much less than 1 part in 5000, it is difficult to justify the terms "conclusive" evidence and "highest accuracy attainable" quoted above.

We are aware that Jager and Dijkstra observed that the refractive index of their samples of tetraethyl silicane showed a variation corresponding with the variations in density, and hence concluded that the latter were, at least in a great part, due to varying traces of impurity, but we believe that this argument is fallacious. There is no direct evidence on the point, but it seems not unlikely that an increase in the proportion of a heavier isotope of silicon in a silicon compound would increase the refractive index of that compound, just as, say, substitution of barium for calcium increases the refractive index of glass.

It happens that during the last three years we have been engaged in preparing to make a re-determination by chemical means of the atomic weight of silicon using, as in the case of boron, samples from widely separated known sources. In the course of this work the opportunity has arisen for one of us to make a careful comparison of the densities of samples of silicon tetrachloride prepared from these sources and subjected to the same very rigorous process of purification. From these densities it is possible to deduce values for the atomic weights of silicon which show a maximum difference of 0·005 unit. These density figures will, we hope, be published shortly, and we give here simply the atomic weights deduced from them together with those cited earlier in this letter.

TABLE.

ATOMIC WEIGHTS OF BORON AND SILICON.

Boron.		Silicon.	
Briscoe and Robinson.	Briscoe, Robinson and Stephenson.	Jager and Dijkstra.	Robinson and Smith.
		Terrestrial 28·051	28·059
10·841	10·847	,, 28·055	28·059
10·825	10 823	,, 28·051	28·058
10·818	10·818*	,, 28·070	28·062
..	..	,, 28·066	28·063
..	10·818	,, 28·062	Mean 28·060
..	10·806	Mean 28·059	..
..	10·788	*Meteoric* 28·060	..
..	..	,, 28·060	..
..	..	,, 28·060	..
..	..	,, 28·066	..
..	..	,, 28·060	..
..	..	,, 28·060	..
..	..	Mean 28·061	..

* Standard.

We do not, of course, believe that the new data for silicon prove that its atomic weight cannot vary, but they do afford evidence that the variation, if it occurs, does not exceed about 1 part in 6000.

H. V. A. BRISCOE.
P. L. ROBINSON.

Armstrong College,
Newcastle-upon-Tyne,
January 26.

Hybridity, Parthenogenesis, and Segregation.

IN a recent paper entitled "On Parthenogenesis originating in Lepidopterous Crosses" (*Trans. Nat. Hist. Soc. of Northumberland, Durham and Newcastle-upon-Tyne*, N.S., 6, Part II.) we discussed certain hybridity experiments between the geometrid moths *Tephrosia crepuscularia*, Bkh., and *Tephrosia bistortata*, Goeze, both of which species had been previously proved to be non-parthenogenetic; in that work conclusions were set out which may be briefly summarised as follows:

(1) These two species cross readily, yielding hybrids which are fertile *inter se* and fertile also when back-crossed on either parent; this fertility continues unimpaired when any of these hybrids are continuously inbred.

(2) Several unmated females, the outcome of crossing *T. crepuscularia* ♀ ♀ and *T. bistortata* ♂ ♂, deposited eggs freely, and in certain cases a small percentage of their eggs developed parthenogenetically.

(3) From these facts we concluded that there was some relation between parthenogenesis and hybridity which, in our opinion, was one of cause and effect.

(4) Specially noteworthy was the fact that the parthenogenetic offspring showed segregation in respect to wing colour, pattern and sex.

These results are of importance inasmuch as the thesis that parthenogenesis could be induced by hybridity had been advanced by Ernst (1918) on theoretical grounds in his "Bastardierung als Ursache der Apogamie im Pflanzenreiche," and accepted by Täckholm, Holmgren and others as a satisfactory explanation of the observed facts in critical genera like Rosa, Erigeron, etc. Whilst we agreed generally with this position, we felt, and therefore stated, that a rigid proof of its validity was lacking, *i.e.* the experimental production of an apogamous hybrid from parents conclusively shown to be non-apogamous had never been achieved.

Our experiments, curiously enough from the zoological side, provided the desired case and we had thought that they were unique. Recently, however, we received papers from Prof. Nabours, Kansas State Agricultural College, which recount his painstaking genetical experiments with grouse locusts (1919, "Parthenogenesis and Crossing Over in the Grouse Locust Apotettix," *Amer. Nat.*, 53, No. 625; 1925, "Studies in Inheritance and Evolution in Orthoptera, V. The Grouse Locust *Apotettix eurycephalus*, Hancock," *Technical Bulletin* 17, Kansas State Agr. Exp. Stn., Manhattan), and afford welcome support to our work. This aspect, however, does not seem to have occurred to Prof. Nabours.

From his 1925 paper (p. 229) Prof. Nabours' conclusions may briefly be quoted: (1) "The members of the species *Apotettix eurycephalus*, Hancock, are bisexual, the fertilised eggs producing males and females in equal numbers, and parthenogenetic, the unfertilised eggs, with rare exceptions, hatching females . . .," and (2) in respect to colour and pattern and, to a less extent, in sex, he asserts "the segregation of factors occurs in individuals producing parthenogenetically apparently to the same extent as in those reproducing bisexually."

Nabours believes that "segregation and crossing over occur before the inception of the parthenogenetic processes," and as a possible explanation of his results, that "the chemical changes which take place during the wait of the pronucleus, in the absence of fertilising sperm, furnish the stimulus to parthenogenesis." Further, he seeks to explain his homozygotes by various hypotheses demanding the doubling of chromosome number.

In view of the essential similarity of these results of Nabours and ours, we consider that one explanation may cover both sets; in short, the solution suggested lies in hybridity.

This opinion receives weighty support from evidence we adduce from Prof Nabours' own papers. In the second (1925) paper he writes (p. 7): "Messrs. Rehn and Hebard[1] have examined specimens of these and definitely determined that they belong to the same species (Nabours, '19)." Turning to the 1919 paper, we find in a footnote (p. 131), "Identified by Mr. Rehn as *Apotettix eurycephalus* Hancock, and by Doctor Hancock as follows: 'nearer the Mexican species *Apotettix convexus* Morse, than the nearly allied Texan species, *Apotettix eurycephalus* Hancock. *Inasmuch as you have used material from both Texas and Mexico in your experiments, it is possible you have hybridised the two* . . .'" (italics ours). Investigations into Prof. Nabours' pedigree tables of the females used in parthenogenesis show that the ancestors can be traced to both stocks, the Texan and the Mexican.

Recognising the implication in this footnote, we submit, therefore, that Prof. Nabours, in supplying from a different group of insects this additional example of segregation under parthenogenesis, has also furnished, although he has not appreciated the fact, a case of parthenogenesis consequent upon hybridity.

A. D. PEACOCK.
J. W. HESLOP HARRISON.

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[1] Hebard is obviously a misprint for Hancock, who is cited as one of the authorities in Nabours' 1919 paper.

Measurement of the Discharge of the Blue Nile through the Sluices of the Sennar Dam.

WHEN the Aswan Dam was completed in 1902, very little was known about the discharge of large sluices of the type constructed at Aswan. By means of a large tank of 22,000 cubic metres capacity, the discharge of one type of sluice 3·5 metres high by 2 metres wide was determined for discharges ranging from 1 to 96 cubic metres per second and for heads up to 13·5 metres above the sill. The discharges of other types of sluice were then compared with those of the standardised type by means of the river level. Thus the discharge of the Nile at the important time of the year is known for monthly periods with a probable error of about 0·6 per cent. (For an account of this see MacDonald and Hurst, *Min. Proc. Inst. C.E.*, Paper No. 4350, 1921.)

The fundamental tank measurements were used as a standard with which to compare the discharges of a series of scale models of the experimental sluice. It was found that the ratio of the discharge of the large sluice to that of its model was closely $n^{\frac{5}{2}}$ where n is the ratio of their linear dimensions. The mean departure of the ratio of the discharges from $n^{\frac{5}{2}}$ using six models and three different scales over a wide range of conditions was 0·4 per cent., and the largest departure for a group of experiments on one model was 4·6 per cent. The condition throughout was that of free discharge into air. (For an account of this work see Hurst and Watt, *Min. Proc Inst. C.E.*, Paper No. 4450, 1924.) The above experiments show that models can be used to predict the discharge of large works, and this is borne out by many experiments made at the Delta Barrage, Egypt, by Mr A. D. Butcher with models of weirs and regulators.

Another result of the fundamental measurements of the river at Aswan was to show that discharges measured by current meters of the Price pattern agree closely with the results of tank measurements, for ordinary velocities of flow. The mean value of (sluice - current-meter) for measurements during the low stage of the river for 3 years is 0·2 per cent.

I have recently completed a series of experiments on a model, scale 1/50, of one of the sluices of the new Sennar Dam on the Blue Nile. These sluices are 2 metres wide and 8·4 metres high, and will discharge under varying conditions of upstream and downstream head, having sometimes a small depth of water above the sill downstream and being at others completely submerged downstream. The discharge of the Dam sluices has been deduced from the model experiments for all conditions. Since the filling of the reservoir was started last July, a variety of conditions has occurred. During this time the discharge of the river has been measured downstream of the Dam every few days by means of a current-meter. It is interesting to state that a comparison of the discharges measured by current-meters and those deduced from the sluices shows that there is good agreement between them. Thirty-five discharges are available, and the mean result deduced from the model experiments is about 3 per cent. greater than that deduced from the current-meters. This may be modified slightly when the current-meters are re-rated.

These results show the value of model experiments. Their principal value is that though they cannot be relied upon to give results in which the systematic error is less than 5 per cent., the accidental errors are small. For many purposes an accuracy of 5 per cent. would be good enough. However, when once the systematic error has been found from a few current-meter measurements well distributed over the whole range of practical conditions, the model can be used to give the discharge of a sluice under any conditions of upstream and downstream level and sluice opening within the range of practical conditions. Information thus becomes available with very little labour which would otherwise take many years and great expenditure of money to collect. In the case of the Sennar Dam, the resident engineer has a table of the discharge of the sluices from the commencement of the working of the Dam, upon which he can base his regulation of the river. Without the model results he would have had to experiment for years after the completion of the Dam before he could have constructed a discharge table for the sluices.

H. E. HURST.

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January 25.

The Fundamental Level of the Iron Atom.

THERE is still some difference of opinion about the fundamental level of the iron atom. From Laporte's analysis (*Zeit. für Physik*, 23, 135, 1924) it appears that the chief lines proceed from five fundamental levels, constituting a quintet *d*-group. But this is at variance with the experiments of Stern and Gerlach on the directional quantisation of atoms. Gerlach states that there is a group of strong lines at about λ = 2100 Å.U., which are not included in Laporte's classification. But Laporte, in support of his view, states that the ^5D group for iron fits best with the rule given by Catalán on the normal orbits of the elements of the transitional series from potassium to nickel (*Journ. Opt. Soc. America*, November 1925). Laporte further states that his point of view "is favoured by some astrophysical facts, and by the almost complete classification of the lines of iron, which now makes it improbable that any important low terms are unknown." I am not aware of the astrophysical facts which Laporte has in view, but such facts as are available to me seem to favour the other view.

In the absorption experiments of Grotrian and Gieseler (*Zeit. f. Phys.*, 22, 245, 1924), the strong group of $^5D - {}^5D'$ lines of the iron spectrum was obtained in absorption at 1250° C., so that this experiment may be interpreted as deciding against the existence of a higher *s*-term. But we cannot hold this sort of evidence to be decisive, because at this temperature of the furnace it is quite possible that a large amount of ^5D-orbits are produced. Once they are produced they will remain fairly stable, for the transition $D \longrightarrow S$ being forbidden, the *D*-states will be metastable. This is supported by evidence from the chromospheric spectrum. The strongest lines in the iron spectrum, λ = 3856·46 and λ = 3860·01, reach in the solar chromosphere a height of 6000 km., and Evershed (*Phil. Trans.*, 201, 470) notes that they are intensified from intensity 8 (Rowland's scale) in the Fraunhofer spectrum to 15 in the flash spectrum, and this behaviour is typical of lines arising from metastable orbits.

Miss Payne in her recent monograph on stellar atmospheres (Harvard Observatory Monographs) has traced the behaviour of iron lines in different classes of stellar spectra. Unfortunately, she has not treated the behaviour of $^5D - {}^5D'$ lines of iron, but of $1{}^5D - 1{}^7F$ lines. These are intercombination lines, and should therefore be strengthened at lower temperatures. At any rate, they enable us to trace the behaviour of Laporte's fundamental (^5D) levels in stellar atmospheres. Miss Payne states that these lines reach a maximum in the *K*2 type of stars. According to the theory of Fowler and Milne this is typical of the behaviour of lines arising from subordinate series. So the astrophysical evidence seems to indicate that ^5D's are subordinate levels. But in order to be certain on the point, the behaviour of either the $^5D - {}^5F$ group lying at about λ = 3700 Å.U. or the $^5D - {}^5D'$ group ought to be traced in stellar atmospheres. The stellar data in this region are not very satisfactory.

Laporte's second point of contention, that the almost complete classification of the iron spectrum makes it improbable that any important low terms are unknown, cannot be regarded as conclusive, and I will illustrate my point by an analogy from the spectrum of neon. All the strong lines of neon obtained within the range λ = 2000 Å.U. to λ = 8000 Å.U. have been classified by Paschen into series, and it has been shown that there are four *s*-levels, denoted by him as s_2, s_3, s_4, and s_5. There are apparently no strong lines left outside Paschen's scheme of classification, yet we now know that these four *s*-levels do not constitute the normal level of neon, because it is perfectly transparent to all radiation from λ = 2000 Å.U. to λ = 8000 Å.U. in the unexcited state. As a matter of fact, Hertz (*Zeit. f. Physik*, 32, 933, 1925) has discovered two strong lines at λ = 735·7 ± 0·5 Å.U. and 743·5 ± 0·5 Å.U., and finds that these can be represented by $x - s_2$ and $x - s_4$. Goudsmit (*Zeit. f. Physik*, 32, 794, 1925), rediscussing the whole data on neon, including Landé's system of grouping the neon series, finds that the term x may be regarded as a singlet *S*-term, having the inner quantum number 0, while Paschen's s_2 is a *P* term of the singlet group, having the inner quantum number 1, and s_3, s_4, s_5 constitute the *p* terms of a triplet group, having the inner quantum numbers 0, 1, 2 respectively.

Here we have the undoubted evidence of the existence of a normal term s_0, which does not give rise to any one of the familiar strong lines of neon. It is now recognised that the spectra of elements having a large number of electrons in the outer ring have more or less a neon-like structure, and if iron, nickel, or cobalt have a still lower fundamental term *s* or *p*, it would not be responsible for any strong lines in the usual range. To find this term, the spectrum in the Schumann region must be very thoroughly investigated, and then only can the point be settled.

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University of Allahabad.

The Constitution of the Heaviside Layer.

IN the issue of NATURE of September 5, 1925, p. 357, Messrs. Breit and Tuve give a method for determining the height of the Heaviside Layer at night. It consists essentially in transmitting a series of impulses and recording them on a receiver at about 7 miles distance. Two groups of impulses were obtained, the time interval between two successive impulses giving the difference in time taken to traverse the two paths, one going direct to the station, and the other by the indirect path up to the Heaviside and back. From the results a height of about 80 km. was deduced.

The authors state that other experiments were tried on a 600 metre wave-length over distances of 100 to 150 miles, but these gave no definite results, there being, I presume, no second impulse due to the indirect ray.

The object of this letter is to point out a possible reason for this failure. At these distances the indirect ray strikes the Heaviside layer at practically 45°, assuming the height of 80 km. is correct. Now if the constitution of the layer is one in which there are free ions and electrons, the pressure being so low that the average time between collisions is large compared with the time period of the waves, a constitution which from other experimental evidence we have reason to expect, and if the wave is polarised with the electric force in the vertical plane, nothing will be reflected at 45° incidence. This angle is in fact the polarising angle of the layer, and is independent of the frequency, and moreover does not depend on how the layer is graded, that is, whether it is a gradual or a sharp transition. Under these conditions only the direct ray will be received, the indirect ray not being reflected.

If this reasoning is correct the results obtained over these distances constitute not only a rough confirmation of the height measurements, but also of the assumed constitution of the layer.

T. L. Eckersley.

Research Department,
Marconi's Wireless Telegraph Co., Ltd.,
Chelmsford.

British Chemical Glass.

Prof. W. E. S. Turner, of the Department of Glass Technology in the University of Sheffield, in a letter to the *Times* of February 15, stated that " this industry . . . owes its inception to Sir Herbert Jackson and the hearty co-operation of several glass manufacturers in 1914 and 1915." I am sure that Sir Herbert Jackson would regret that the sole credit should be given to him and no mention made of Prof. Meldola, the chairman under whom he worked, and I trust, therefore, that Nature will be able to find space to correct a statement so deficient as that made in the *Times*.

So early as August 29, 1914, Meldola realised the difficulties ahead, and wrote to a colleague: "I think of preparing a general plan of campaign for recovering British chemical industries lost through German competition." On September 22 he presided at a joint meeting of the Councils of the Institute of Chemistry and the Society of Public Analysts, at which special committees, one of them dealing with glass, porcelain, and filter-paper, were appointed. He was chairman of the latter committee and also of the special Glass Research Committee appointed on October 30 by the Institute of Chemistry. He presided at nearly all the numerous meetings of this committee, attending one only three days before he died, " working to the very last in his great desire to advance the interests of his country and of chemical science." I quote the words of his colleague, Prof. E. G. Coker, in the brief reminiscences of Meldola published by Williams and Norgate in 1916.

The letter which appeared in the *Times* is sufficient proof that these facts are not known as they should be or have passed out of mind. Nevertheless, there must be many who remember the debt that is owing to Raphael Meldola, and they surely will " see to it that his name be not forgotten."

Edward B. Poulton.

Oxford, February 25.

Names for Companion Stars.

Although it has not been customary to give specific names to the dark or inconspicuous companions of bright stars, there are one or two such bodies of so much interest and importance, and likely to be so constantly referred to in the science of the future, that perhaps exceptions might be made in their case. I write, therefore, to ask whether an outsider in astronomy may modestly make a suggestion for astronomers to consider, and to reject if they do not approve.

The companion of Sirius is so extraordinary a body, and the detection of its specific properties is the outcome of such brilliant work, that I suggest that the name Eddington might be applied to it. Presumably less is known about the companion of Algol—the first spectroscopic binary—and possibly, as it seems dark, it scarcely deserves a name; but the name of its discoverer, Vogel, might perhaps be attached to that.

These suggestions may be rather presumptuous; but no harm seems likely to be done by their publication.

Oliver Lodge.

February 6.

The Nature of Active Nitrogen.

I have not been able to follow in detail the recent discussion on the nature of active nitrogen, being closely occupied with other problems. It seems worth while, however, to direct attention to a part of my early work which seems to have dropped out of notice, but is, I believe, worthy of attention (Strutt, *Proc. Roy. Soc.*, A, vol. 86, pp. 264-267, 1911). It is there shown that the luminosity of active nitrogen can, as it were, be squeezed out of it by compression, the luminous emission of the α (1st positive) group of bands, and, perhaps the other series also, but this was not investigated, being immensely enhanced by compression. When the old volume is restored, it is found that the capacity to produce the glow is exhausted, though, apart from the compression, it would have lasted much longer.

The experiment was regarded at the time as proving that the action is bi-molecular, and I think is at least as telling as any other evidence pointing in the same direction.

Rayleigh.

Terling Place, Chelmsford,
February 27.

As the result of investigations which have been proceeding for some time, the writer, in collaboration with Dr. E. K. Rideal, has been able to show by three independent methods that the heat of formation of active nitrogen is about – 43,000 cal per gm. molecule.

This is in agreement with the value suggested by Strutt in 1911, and since it is known that the heat of dissociation of the nitrogen molecule is most probably of the order of – 300,000 cal. per gm. molecule, the hypothesis that active nitrogen is atomic cannot well be substantiated. Rather would it appear that 'active' nitrogen represents a metastable molecule at not a very high energy level.

A full account of the investigations will shortly be published.

E. J. B. Willey.

Department of Physical Chemistry,
University of Cambridge.

A Mistaken Attribution in South American Linguistics.

With reference to the note under the above title in Nature of February 20, p. 283, it may be of some interest to point out that the Arda in question no doubt refers to Ardra, Arder, or Allada, formerly one of the greatest towns on the Dahomian coast, which was conquered by King Agaja of Dahomey in 1724. The inhabitants speak a variety of Ewe, very similar to the ordinary Popo.

There was a considerable trade in slaves between Dahomey and the Brazils, and it is conceivable that descendants of Ardra slaves penetrated to the part of Amazonia mentioned in the text.

P. Amaury Talbot.

Bishopton,
Stratford-on-Avon,
February 22.

The Species Problem and Evolution.[1]

By O. W. RICHARDS and G. C. ROBSON.

II.

CORRELATION.

THE mutual relation and interaction of the various characters by which species are distinguished from each other is very imperfectly understood at present. On one hand, all the characters distinguishing a species may, or may not, form an integrated system. On the other hand, certain characters may be correlated with one another to some extent. The possibility that the characters of different species may form integrated systems is at present very uncertain. The only evidence in support of this view is derived from certain inter-specific crosses in which the parental characters segregate *en bloc*; and further investigation of this subject is urgently needed.

Whenever two characters always seem to occur together they may be related as cause and effect, or both may be due to the same cause. When this is the case, and when the effect cannot be traced clearly to the cause, such a relation will be called merely correlation. Two characters may be also correlated by genetical means, either being linked or by a varying number of individuals of a population being homozygous for both of them. These types of correlation will rarely be absolute. The former must be of some importance, but cannot be a universal explanation of correlation, since it will not often happen that all the characters that are found to be correlated in a species are due to genes situated in the same chromosome. The latter means of correlation is certainly of wide importance; perhaps two characters which are highly correlated in a species, but segregate out when an inter-specific cross is made, are always correlated in this way. A special agency must obviously be invoked to account for the existence of a character in the homozygous condition in most of the individuals of the species when it arose originally in only a few.

ISOLATION.

In this section are to be considered causes of isolation other than topographical barriers. A number of explanations have been put forward to explain failure to interbreed on the part of species which seem to have every opportunity of crossing. Thus it has been supposed that differences in the copulatory organs might produce a mechanical barrier between species so differing. Such mechanical isolation, however, can not often be effective. In the first place, when such differences in the copulatory organs do occur, they are often restricted to the male and, when comparable differences occur in the female as well, no coadaption of the organs of the two sexes has been shown (Boulangé, 1924). Furthermore, species which differ in their genitalia have been crossed without mechanical difficulty.

There are many cases known in which closely allied forms living together with ample opportunities for interbreeding rarely cross in Nature. The cause of this disinclination to interbreed ('selective mating') can rarely be assigned to known differences between them. There are certain factors which may be important in particular cases, for example, differences in scent and mating-behaviour. Selective mating may even occur within a species; for example, Crozier (1918) has shown that in Chromodoris the pairs that interbreed tend to be of the same size and that large specimens rarely mate with small. Where differences in habitat and seasonal occurrence exist, they more obviously produce some degree of isolation; but it is not often that either of these alone would be completely effective. As we have seen, none of these modes are universal causes of isolation when acting alone; but in any case in which several were involved at the same time, isolation might be nearly complete. When interbreeding is not stopped by any of these means, sterility may yet make it ineffective. In motile animals, in which alone selective mating can occur, sterility is not necessarily a primary cause of isolation. It has been already seen that it by no means always precedes or even accompanies the early stages of structural divergence. In these forms probably some kind of selective mating is most often the cause of isolation, and sterility is due to later divergence.

In forms in which the male fertilising element is carried to the ovum by external agencies (for example, in plants and sessile animals, etc.), isolation can only be produced by differences in breeding-season or by sterility. Although in some species isolation is produced by the former means, it is probably not in the majority, and the latter must be more or less sterile when crossed. In the case of plants there are some genera in which the species concept breaks down owing to the absence of marked sterility or any other means of isolation among the members.

EVOLUTION.

The initial stages of evolutionary divergence involve three processes: (1) the occurrence of variations, (2) the spread of new variations in a species, and (3) the break-up of a species into different populations.

1. The origin of heritable variation is still very obscure, and in particular there is as yet no clue to the origin of those changes in habits which must have played so important a part in evolution. There may be said to be three main views on this subject: that heritable variation is the result of automatic change in the germinal material, that it is due to change produced in the germ cells by external causes, and that it is the effect of change produced by such causes in the soma and transferred to the germ cells. In practice it will be difficult to distinguish between the second and third of these.

The experiments which have been conducted to elucidate this problem are by now numerous; but in spite of them the problem is still unsolved. For one reason or another, the results which are claimed to prove that the effects of the environment can be transferred from the soma to the germ cells have had to be rejected or are still *sub judice*. Each of these experiments is of course entitled to separate consideration, and some are of greater merit as experiments than others. With justice, however, it must be said that they do not as yet collectively form a convincing body of evidence.[1]

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[1] Continued from p. 347

Of the direct modification of the germ cells as a factor in evolution we have likewise no decisive proof, though there is some circumstantial evidence in favour of this possibility. The means by which the germ cells have been experimentally modified rarely seem, however, to bear any relation to the natural environment of living organisms. It is a fair criticism to suggest that very few of the experiments designed to elucidate this problem reproduce those environmental circumstances in which evolutionary change must be assumed to have taken place.

The action of the environment may perhaps be seen in the following examples, in which, however, it is difficult to say whether the effects have been on the germ cells and soma or on the germ cells alone. These examples fall into two classes. On one hand, the species of a genus may be so distributed that they occur at different points in the gradient of some environmental factor (for example, temperature, humidity) Some special variation in the species (for example, hair-length) may be correlated with the change in the environment. This variation may be seen both within a species in different parts of its range and by the comparison of species the ranges of which include different parts of a gradient. When a character shows a correlation with changes in an environmental gradient, it is of course difficult to prove that the changes in the character are neither phenotypic nor adaptive, though in particular cases this may be most unlikely. On the other hand, there are a number of cases in which in allied species identical morphological varieties are of two kinds—heritable and non-heritable. For example, Crow (1924) has given examples in the Algæ of characters which are only developed in special environmental conditions in one species, but appear to be genetically fixed in others. Though these examples prove nothing as yet, they suggest a useful line of inquiry into the causes of variation.

In order to explain certain special types of evolutionary phenomena, some authors have recourse to two theories which are sometimes confused—the principles of Orthogenesis and of Momentum and 'Programme Evolution' (Eimer, W. Lang, Dendy, Osborn). The former principle expresses the idea that in allied forms, for an indefinite time after divergence, there is an innate capacity to produce the same type of variant. If this were true in a wide sense (which is not yet shown) it would be wrong to assume that species could respond to environmental change by variations in all directions. The terms Momentum and Programme Evolution, though not applied to identical phenomena, seem to have very much the same implication. One refers to the development in certain groups of monstrous or over-complicated structures; the other is applied to 'determinate' evolutionary series, which are accomplished without any apparent reference to Natural Selection or any other principle. At present, however, these three terms are labels for types of evolutionary phenomena which are of obscure causation and uncertain frequency.

It is perhaps necessary to point out that possibly new forms may arise by fresh combinations of pre-existing characters. There is a certain body of evidence that has been thought to show that new species may arise as a result of crossing. This evidence and the corresponding cytological data relate almost exclusively to plants. The rôle of this process in evolution is as yet very uncertain, and, if it is operative at all, its effect is probably limited.

2. The process of divergence by which species arise consists either of the consecutive differentiation of one character after another, or perhaps in the change of a large set of characters *en bloc*. For the occurrence of the latter there is only a little evidence which has been mentioned previously. Variations as a rule must arise in a few individuals, except where the environment has some identical effect on all the members of the species; so that as a rule the addition of new characters implies the spread of variations in the population. This is usually supposed to take place mainly by the action of Natural Selection, which ultimately requires that species must differ in adaptive characters.

In the first place, it is practically impossible to show that a character is not of value to an organism without an exhaustive knowledge of the life history and physiology of the latter. On the other hand, the adaptive value of a structure must not be presumed in default of evidence to the contrary. A character can only be called adaptive (*a*) if it is useful, (*b*) if its possession does not entail a counterbalancing disadvantage. In the following discussion it is merely the utility of characters which will be considered.

A character which is not directly useful may be correlated with a useful one, as Darwin suggested. It would be a very difficult thing, however, to give an example of this in which the character is specific. No doubt such cases do occur, and perhaps even frequently; but they cannot be assumed to play an important part in evolution until direct evidence of their frequency is forthcoming.

The direct utility of the characters previously described as specific may now be considered.

(*a*) *Structural.*—There is not very much satisfactory evidence of the utility of the differences between closely allied species. There are some observations (summarised by Pearl (1917)) which suggest that certain small structural characters may be of selective value, though Pearl points out that other investigations of this sort yield no such result. It is also the case that, when allied species differ in their mode of life, their structural differences do not in general seem to be connected with such differences in the habits (but cf. Regan, 1925, p. 5).

(*b*) *Physiological.*—The evidence here is very unsatisfactory; but such physiological differences between allied species as are known are not yet shown to be of survival value.

(*c*) *Reproduction.*—It is difficult to see any sense in which the differences in sterility between crosses can be adaptive. As regards the differences in secondary sexual characters, some seem to be quite unconnected with mating, and many of them are very unlikely to be directly useful. Any character which plays a part in mating may, however, have been influenced by some form of sexual selection.

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[1] Since this article was written, an important paper by Messrs. J. W. Heslop Harrison and F. C. Garrett has appeared (*Proc. Roy. Soc.* B, 99, Feb. 1926, p. 241) on the inheritance in Lepidoptera of melanism induced by the presence of lead and manganese in their diet. These results seem in general to be above criticism, but their precise significance cannot be discussed in this brief notice.

(*d*) *Habitat and Food.*—When allied species differ in habitat and food it has been assumed that they are structurally or physiologically adapted to such divergences; yet it is not only in many cases quite unproved that such adaptations occur, but even if they do occur it is very uncertain which type of difference was primary. The rôle of Natural Selection in producing such differences is very dubious

(*e*) *Miscellaneous Differences.*—It is difficult to find any case in which survival value may be attributed to the differences in behaviour which come under this heading.

It thus seems that the direct utility of specific characters has rarely been proved and is at any rate unlikely to be common. Furthermore, since the correlation of structure, etc., with other characters shown to be useful does not at present rest on many well-proved examples, it cannot yet be assumed that most specific characters are indirectly useful. Thus the rôle of Natural Selection in the production of closely allied species, so far as it is known at present, seems to be limited. This statement is not to be taken as a wholesale denial of the power of Natural Selection. The latter is not in question when structural differences of a size likely to effect survival are involved. It is only the capacity of selection to use on a large scale the small differences between closely allied species that is unproved.

Recently another process which occurs in Nature has been suggested as a possible cause of the spread of characters whether adaptive or not (Elton 1924). Many animals are subjected to severe fluctuation in numbers through epidemics, bad weather, etc., and this has two possible effects. The usual result would be that the small number of individuals left over after, for example, an epidemic, would not include many of the uncommon variations, and the number of different variants in the population would be continually limited. After a minimum there is of course room for many more individuals than are actually found, so that during the subsequent multiplication there may be little or no competition. If an uncommon variant survived by accident, or if an unusually low minimum did not leave a random sample of survivors, then in the course of multiplication the character of the population would be changed. At present this seems to be the most likely means by which an entirely unadaptive character could spread.

3. If variations arise in only a few individuals at a time, they will not often be spread quickly to all the members of a species, so that if samples of a widely distributed species be taken from different parts of its range they are likely to differ in the collection of characters which distinguish them. Such difference will be further accentuated if the area occupied is broken up by topographical barriers which may cause isolation. This, however, to be permanent must be grounded in some of the other causes referred to above (for example, selective mating). Some animals live in colonies, such as certain land snails (Cepea) and moths (Zygaena). Of these the former have a limited power of dispersal, while the latter, in spite of their power of flight, tend to keep to their own colonies. Adjacent colonies which are not separated by impassable barriers may differ in the same way as do the geographical races of widely distributed species. Thus two forms living at separate points in the range of a species may differ in a number of characters which, acting in conjunction, may cause isolation, while neither of them would differ from its next-door neighbour enough to produce this result. It has been suggested that most widely distributed forms constitute such "syngamic chains" (Poulton). Anything which breaks this chain would isolate two groups which sooner or later might become two distinct species. The origin of variation in habits within a species is at present not yet well enough known to enable us to make further generalisation about the methods by which isolation is produced.

Conclusion.

There are many characters (structural, physiological, etc.) by which species may be distinguished, but differentiation does not take place to the same extent in all of them, and sometimes, as criteria, they are at variance with each other. As no standard can be proposed by which species may be distinguished from varieties, there is no absolute criterion of species. Failure to interbreed is perhaps the nearest approximation to such a criterion, and it is also possible that a special type of sterility may be revealed which might provide a more definite limit than that indicated by structure. The nature of the various grades of sterility, however, requires a more complete analysis. At present the incidence of specificity is very imperfectly understood, especially in physiological characters. Even in structural divergence it is not yet known why in each group of animals certain organs tend to show the effects of divergence sooner than others.

Causes which in theory should spread new characters through a population are known; but much more evidence is required as to their actual operation and as to the extent and nature of the correlation that has been observed between specific characters. It is very unlikely that divergence at its earliest stages is promoted to an important extent by Natural Selection. In Nature, species are more or less broken up by causes leading to permanent isolation. These causes may be numerous; but at present we know very little as to the *primary* cause in any particular case—whether, for example, divergence in habit precedes that of structure or vice versa, and whether sterility precedes or follows structural divergence. Finally, there is very little exact knowledge as to the physiological differences which must occur between forms having different habits.

Bibliography.

(1) Bateson, W., 1913, "Problems of Genetics," chapter xi (*passim*)
(2) Boulenger, H., 1924, *Mem Trav Fac. Catholiques de Lille*, Fasc. 28
(3) Crow, W B., 1924, *Journ Genetics*, 14, No 1, p 115
(4) Crozier, W., 1918, *Journ. Exptl Zool.*, 27, p. 247
(5) Elton, C., 1924, *Brit Journ Exptl. Biol.*, 2, p 119
(6) Gerschler, W., 1924, *Zeits. ind. Abst. u. Vererb.*, 12, p 73
(7) Kemp, S., 1915, *Mem Ind. Mus.*, 5, No 3, p. 265 and foll
(8) Lundbeck, W., 1922, "Diptera Danica," Pt VI p 157.
(9) Lyle, G., 1925, *Ent Monthly Mag.*, May-June, p 121.
(10) Newman, J., 1915, *Journ. Exptl Zool.*, 18, p 511
(11) Pearl, R., 1917, *American Naturalist*, 51, No 602, p. 65.
(12) Philipps, 1915, *Journ. Exptl Zool.*, 18, p 69
(12a) Regan, C T., 1925, Rept Brit Assocn Sect D, Pres. Address, p. 5
(13) Tutt, J. W., 1899, "British Lepidoptera," 1, p. 164

The Electrical State of the Upper Atmosphere.

THE meeting of the Royal Society on March 4 was devoted to a general discussion on the subject of "The Electrical State of the Upper Atmosphere," at which a number of prominent physicists interested in this subject had been invited to take part. The large attendance at the meeting showed the importance of the subject in the scientific world at the present time; and it was evident that a very useful purpose was being served in directing the attention of the meteorological and atmospheric physicists to the insistent demands made by modern wireless research for an upper ionised stratum in the atmosphere which is capable of deflecting wireless waves and returning them to the earth's surface.

In opening the discussion, the president of the Royal Society, Sir Ernest Rutherford, outlined the three possible methods of investigating the upper atmosphere. Above the limits of direct observation, the pressure and temperature are to some extent calculable, while observations on meteors provide experimental information. The highly penetrating radiation recently investigated by Millikan was found to increase in intensity upwards from the earth's surface, and the suggestion was made that this radiation might possibly originate in thunderstorms. It was pointed out that in order to obtain a permanently ionised layer it is not necessary to assume a very strong ionising agent; since, owing to the slow rate of recombination at the higher levels, a small rate of production of ions may result in a very large permanent ionisation

With the aid of a carefully prepared chart, Prof. Sydney Chapman, of the Imperial College of Science and Technology, then summarised our present knowledge of the physical constants of the atmosphere. By means of self-registering instruments carried in sounding balloons, direct observations have been made at heights up to 30 km. The absolute temperature of the atmosphere decreases from 285° at the earth's surface to 220° at a height of 10 km., which is the upper limit of the troposphere. Above this the temperature remains constant up to a height of 60 km., where it begins to increase again to a value approaching 300° for a height of 100 km. At this height the pressure and density of the air have values which are about 10^{-5} of those at the ground level, while the mean free path of the molecules increases from 10^{-5} at the earth's surface to 3 cm at 100 km. height. The gaseous constituents of the atmosphere are thoroughly mixed as the result of winds in the lower regions, but they become separated at the higher levels with nitrogen as the main constituent The existence of aurora at heights of from 90 km. upwards appears to require the lifting of gases from the lower regions. Attention was further directed to the comparatively high conductivity which the ionised layer is required to possess in order to explain the phenomena of terrestrial magnetism

Mr. C T. R. Wilson referred to recently published data on thunderstorm distribution, from which it has been deduced that about 1800 thunderstorms are in continual progress over the earth's surface, accompanied by lightning flashes at an average rate of one hundred per second. Combining these results with the experimental measurements of the quantity of electricity in each lightning flash, it was shown that these thunderstorms represent an energy supply having the enormous value of 10^{11} watts, which, however, is only 10^{-4} of the energy received by the earth from the sun in the form of heat. It was suggested that electrons moving in electric fields with strengths of the order of 10,000 volts per cm. in the neighbourhood of lightning flashes, may be responsible for a very penetrating form of radiation in the atmosphere. In a later portion of the discussion Mr. Dobson described results obtained in observations on the disappearance of meteors and showed that this leads to increased values for the temperature and pressure of the atmosphere at heights of the order of 100 km.

The radio aspect of the discussion was opened by Sir Henry Jackson, who emphasised the long-felt need of an adequate explanation of long-distance wireless signalling, of the variations in signal intensity, and of the more recently observed variations in apparent directions of arrival of wireless waves at a receiving station. He stated that during the last few years an enormous amount of experimental data on these points has been obtained by a group of investigators associated with the Radio Research Board and that the experimental facts are now well established. All this work indicates the necessity for a layer in the upper regions of the earth's atmosphere which is capable of deflecting waves reaching it in such a manner as to return them to the earth's surface. A brief account was also given of some recent experiments carried out on a wave-length of 12 metres in which a ship transmitter was employed. As the ship proceeded away from the receiving station the signals disappeared for a range of transmission of about 100 miles. This was presumably due to the high attenuation of such waves in travelling over the earth's surface, although accurate knowledge on this point is still lacking. As the ship proceeded on its course no signals were received until the distance was increased to 1100 miles, beyond which the signals again disappeared. At 3000 miles and again at 6000 miles the signals were very clearly heard, although they were inaudible at intermediate ranges. Such results as these demand for their explanation an ionised layer which will permit the passage of wireless waves with a very small attenuation and will arrange for waves to be returned to the earth at certain places only.

Prof. E. V. Appleton indicated the desirability of investigating the wireless phenomena at comparatively short distances, and then described two sets of experiments, carried out with the assistance of Mr. M. A. F. Barnett, which provide proof of the reception of downcoming wireless waves at the earth's surface. The first of these demonstrated the interference between two sets of waves from the same transmitting station, one set having travelled along the earth's surface and the other set via the upper regions of the earth's atmosphere. The second experiment was based on the fact that, for an electromagnetic wave arriving at the surface of a conductor, the resultant horizontal magnetic force is greater than that of the vertical electric force, and by measuring the ratio of these forces the angle of incidence of the waves can be calculated. Attention was directed to the importance of the earth's magnetic field on the operation of the ionised layer, and also to the fact that, from observations on very short wave-lengths, information is obtainable as to the density of electrons required in this layer.

The next contribution to the discussion was made by Dr. R. L. Smith-Rose and Mr. R. H. Barfield, who gave a brief account of some of their recent experimental measurements on wireless waves received from the upper atmosphere. By means of careful measurements of the directions of both the electric and magnetic forces at the earth's surface due to wireless waves from a distant transmitting station, it was shown that, at times in the neighbourhood of sunset and in the hours of darkness, some of the received waves were travelling in a downward direction, evidently the result of deflexion from the upper atmosphere. Several methods of measuring the angle of incidence and relative intensities of such waves have been developed and give consistent results. In an example given in the paper, the angles of incidence varied from 13° to 34°, and the latter value is shown to correspond to a height of deflecting layer of about 88 km, which is in good agreement with the results of other investigators. The intensity of such downcoming waves is of the same order as the direct wave along the earth's surface which is received simultaneously, and the combination of the two sets of waves is responsible for the variations in signal intensity in the readings of a direction-finder which were observed during the experiments. The need for further investigation and the lines of proposed future experiments were mentioned by these speakers.

In concluding the radio side of the discussion, Prof. W. H. Eccles reminded the audience that the observed effects might vary very much over the enormous range of wave-lengths which is now being used in practical wireless communications. The diffraction of the waves around the curvature of the earth would be appreciably different with wave-lengths of, say, 20 and 20,000 metres, and it is also possible that the shorter of these waves may be returned to earth at a comparatively low height, about 30 km, in the atmosphere. The speaker directed attention to some lacunæ in the Larmor theory of the propagation of waves, and emphasised the need of further experiments directed towards the elucidation of some points which are at present somewhat obscure.

Among the speakers who took part in the later portion of the discussion, Dr. G. C. Simpson stated that Britain now leads the world in the matter of knowledge and research on the science of the upper atmosphere.

Transatlantic Radio Telephony.

ON Sunday, March 7, the General Post Office gave representatives of the Press an opportunity of taking part in the engineering tests, made in the ordinary course, by the technical staffs of the General Post Office and the American Telegraph and Telephone Company. Mr. Shaughnessy, the engineer in charge, gave an interesting résumé of what has already been done. He also described the route that is travelled by the voice signals and detailed some of the many difficulties that will have to be overcome before two-way telephony between London and New York can be established on a commercial basis. So far back as 1914 the engineers of the Bell system in the United States succeeded in establishing one-way communication between Arlington and Panama, San Francisco, Honolulu and Paris successively. Three years ago similar experiments between London and New York proved that it was highly probable that a limited two-way service could be established.

In England, the circuit ends at the London Trunk Exchange of the British Post Office. In the United States it is terminated at the headquarters of the American Telegraph and Telephone Company at 24 Walker Street, New York City. In speaking from London, the signals are carried by underground telephone wires through two repeater stations direct into the microphone of the Post Office Radio sending station at Rugby, where the aerial used is carried by five lattice masts each 820 ft high and a quarter of a mile apart. The radio signals then go a distance of 2900 miles to the receiving station at Houlton, Maine From there they traverse a distance of 600 miles through two repeater stations to New York.

In transmitting from New York the speech is carried a distance of 70 miles to the sending station of the Radio Corporation at Rock Point, Long Island. From there it is transmitted by radio a distance of 3300 miles to the Post Office receiving station at Wroughton, near Swindon. From this point it is carried over a telephone circuit to London, a distance of 90 miles

The wave-length utilised in England is 5770 metres and in the United States 5260 metres The power used at each end is about 200 kilowatts, but owing to improvements in the method of radio transmission adopted, the ordinary broadcasting telephony station would have to employ about double this power to attain the same efficiency.

Arrangements were made by means of which some twenty press representatives in London had two-way conversations with their American confrères. These conversations could be overheard by all those present. The speech was remarkably clear, being quite equal to that heard in ordinary telephony. It was stated that the atmospheric conditions were favourable. Very little disturbance was produced by Morse or atmospherics. The difference between the voices of the speakers was clearly recognisable. This was the first occasion on which group conversations by the public were held between London and New York.

The Post Office engineers are to be congratulated on the many difficulties they have overcome, particularly in balancing the land telegraph lines in order to get two-way transmission. We are still, however, a long way from commercial telephony across the Atlantic. Doubtless it will come in the future. We wish the engineers every success in their strenuous endeavours.

Obituary.

Prof. A. R. Cushny, F.R.S.

The sudden death of Prof. A. R. Cushny, professor of materia medica and pharmacology, University of Edinburgh, at the early age of sixty years, is a severe loss to medical science and to pharmacology in particular, for he was one of the chief pioneers of this science. The outstanding events in his career are as follows:—He was educated at the University of Aberdeen, and then studied on the Continent, and from 1892–1893 was assistant to Schmiedeberg at Strasbourg. In 1893 he went to the University of Michigan as professor of pharmacology, and in 1905 returned to England to take the chair of pharmacology at University College, London. In 1918 he went to Edinburgh to take up the post he held until his death.

Cushny made many important contributions to our knowledge of pharmacology and physiology, but his name is associated particularly with his investigations upon the mode of action of digitalis on the heart, and upon the secretion of urine. Whilst at Michigan, he carried out a series of researches of fundamental importance which established the mode of action of digitalis on the mammalian heart; and later in London, in association with his friend the late Sir James Mackenzie, he applied the knowledge gained in these researches to the study of the therapeutic action of digitalis. In 1925 he summarised our present knowledge of this subject in a monograph on digitalis and its allies.

Cushny carried out numerous important researches on the mode of secretion of the urine, and in 1917 he published a monograph, in which he advanced the first coherent theory regarding the secretion of urine which accords at all with modern ideas of physical chemistry.

It is as one of the chief pioneers and founders of the science of pharmacology, however, that Cushny will be especially remembered. In 1899 he produced the first edition of his well known "Textbook of Pharmacology and Therapeutics," which was the first systematic textbook on this subject to be published in English He had a very remarkable power of shrewd and balanced judgment, and this was based not only on an exceptionally wide knowledge of pharmacological literature, but also on a personal knowledge of all the leading pharmacologists in the world. This combination of knowledge and judgment gave his textbook an unrivalled authority. His whole influence was thrown towards making pharmacology an exact science, and he admitted no tradition of therapeutics as a fact unless it was supported by definite evidence. For these reasons, the work has had a profound influence on the development of pharmacology in Great Britain and has greatly assisted the growth of the subject as an exact science.

Cushny's personality made him an exceptionally fine teacher and inspirer of research. His kindness and patience were inexhaustible, but his wide knowledge and shrewd judgment made him the natural enemy of anything like slack or inaccurate work. He founded the school of pharmacology at Michigan and made it an important centre of research, and repeated this performance in London. Finally, when he went to Edinburgh he found research work in Pharmacology at a low ebb and in a few years established a strong school. Cushny was the senior pharmacologist in Britain, and his wide experience and knowledge, his strong but kindly personality, and his great powers of judgment, made him the natural leader of his scientific colleagues, and also one whose advice was greatly valued on matters scientific, academic, and personal.

In addition to his scientific and academic activities, Cushny also served on numerous commissions and other public bodies, notably on the Chemical Warfare Committee, the Central Control Board (Liquor Traffic) and the Council of the Royal Society.

Cushny was a great pioneer and leader, and his untimely death is an irreplaceable loss to the medical sciences. Those who, like the writer, worked under him as assistant, have double cause to mourn the loss of a great teacher and kindly friend. His circle of friends was world-wide, and the sympathy of all will be extended to his widow and daughter in their sudden bereavement.

Prof. D. S. Capper.

Prof. David Sing Capper, who died from heart failure following acute rheumatism on February 12 at his home in Golders Green, was for twenty years professor of engineering in the University of London, King's College. He retired from this position in 1921 to devote himself to the commercial side of engineering. At the time of his death—he was only sixty-one years of age—he held the position of director in the Haulage Improvement and Constructions, Ltd., a company interested in the development of mechanical road transport.

Prof. Capper's early training, like that of most educated Scotsmen of his time, was of a wide and varied nature with a classical bias. After taking his degree at Edinburgh, he adopted the engineering profession and studied for some time at University College, London, under Sir Alexander Kennedy. His practical experience was obtained first as a pupil with Messrs. R. and W. Hawthorns of Leith, and later with Messrs. Humphrys, Tennant and Co, of Deptford, where for two years he acted as assistant to Mr. R. Humphrys. He took an energetic interest in the proceedings of the principal engineering societies, and was a member of the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Junior Institution of Engineers.

Prof. Capper was appointed professor of engineering at King's College, Strand, in 1890, and in 1905 he published, in the First Report of the Steam Engine Research Committee, the results of his long and important research on valve leakage carried out under the auspices of the Institution of Mechanical Engineers. The same year he became a member of the Senate of the University, and so many-sided were his manifold educational activities that at different times he had the distinction of being a governor of Sir Roger Cholmeley's School, a member of the governing body of the Imperial College of Science and Technology, and a member of the delegacy of King's College. He gave of his best in such services, where his long experience, persuasive manner, an almost uncanny quickness in summing up the gist of a resolution, and an unfailing sense of the feelings of a meeting, made his presence a great asset.

Consistent with his leaning towards the practical side of his profession, Prof. Capper carried on a consulting practice for many years in addition to his other duties. Incidentally he was one of the pioneers of the 'Sandwich' system of training for engineers, wherein a student gained works experience with some well-known engineering firm in tandem with his college degree course each year for four years, instead of the usual three at college only.

When in 1908 Lord Haldane introduced his plans for the formation of Officers Training Corps at the various universities, Prof. Capper threw himself into the scheme with whole-hearted enthusiasm, and with characteristic zeal undertook the difficult task of commanding the University of London contingent. Later, with a stimulating sportsmanship, he passed all the examinations, and through every stage in the training curriculum of a territorial officer, from the barrack square at Chelsea to the School of Musketry at Hythe. In August 1914 he took command of a training camp for two hundred young officers at Headley, and eventually commanded various training schools for officers. He transferred to the 2/5th Royal Warwicks in 1916 as temporary major, readily sacrificing his rank of lieut.-colonel in his keenness to serve overseas. Then at the age of fifty-one years this university professor went out into the trenches as second in command of an infantry battalion; an example of patriotism and pluck which is worthy of record. Early in 1917 he was invalided home on account of heart trouble and transferred his energies to the Ministry of Food, where he assisted in a research on food preservation until the end of the War, when he returned to his duties at King's College.

O. S. S.

WE much regret to record the death, on February 26, of Mr. Henry Hatfield, I.S.O., barrister-at-law, for more than thirty years Chief Examiner at the Patent Office. Born at Stockport in 1854, and educated at Owens College, Manchester, and the Royal College of Science, Dublin, Mr. Hatfield intended to enter for the Geological Survey. He went to the Patent Office instead, however, in 1878, becoming Chief Examiner in 1888, and later was authorised to act for the Comptroller-General. During his regime many changes in patent procedure were inaugurated, notably the modern methods of 'search' by a scientific staff. To the general scientific public, his work in connexion with the founding of the Patent Office Library, which has now become one of the best scientific libraries in Great Britain, will be better known.

News and Views.

A LARGE company of the Royal College of Science Association and others assembled at the Imperial College Union, South Kensington, on Friday last, March 5, on the occasion of a complimentary dinner to Sir John Farmer, professor of botany in the College, upon whom the honour of knighthood was conferred by the King at the beginning of this year. Sir John Farmer is the senior professor of the Royal College of Science, and when the Imperial College was instituted by Royal Charter in 1907 for the purpose of giving the highest specialised instruction, and providing the fullest equipment for the most advanced training and research in various branches of science, especially in its application to industry, doubt was expressed as to whether botany could appropriately be brought within the contemplated scheme. Fortunately, its economic significance was realised, with the result that the department devoted to instruction and research in this branch of science has become of the greatest value in the development of the plant resources of the British Empire. Students trained by Sir John Farmer now hold responsible posts in educational institutions, agricultural stations, and great plantations throughout the Empire, and when he visited Trinidad a year or so ago, as many as five in that single place were at the port to welcome him. Mr. Herbert Wright, who proposed the toast of the guest of the evening, testified as an old student to the wide and stimulating influence of Sir John Farmer's work. To have established a school of pure and applied botany which has contributed so much to scientific progress and practical service is a great achievement, and we cordially associate ourselves with Sir John Farmer's colleagues and students in congratulating him upon it and the recognition of his work represented by the honour recently conferred upon him.

PROF. ARNOLD SOMMERFELD, who on Wednesday, March 3, delivered the first of a course of three lectures on "Atomistic Physics" at the Imperial College of Science and Technology, under the auspices of the University of London, is one of Germany's leading mathematical physicists. He is now professor of physics at the University of Munich, where he is a colleague of Prof. Wien, who visited Great Britain last year Prof. Sommerfeld was born in 1868, and during the early years of his career published many papers on various branches of theoretical physics and pure mathematics. He is known chiefly, however, on account of his more recent work in developing the application of the quantum theory to the problem of the spectra of the elements, initiated by Bohr. Independently of Wilson he showed that by a generalisation of Bohr's original theory of the hydrogen atom to include the possibility of elliptic orbits, and the introduction of the relativistic change of mass with velocity into the equations of electronic motion, the existence of a 'fine-structure' of the series lines of hydrogen and ionised helium might be expected—a prediction which was brilliantly verified in the case of ionised helium by Paschen. Later he introduced into the discussion of spectral term-relationships the idea of 'inner quantum numbers,' which, since the discovery of multiplets by Catalan, has received a very wide application His book, "Atombau und

Spektrallinien," first published in 1920, has already passed through four editions, and is recognised as the standard work on the subject. It has been described as 'the twentieth century bible.' An English translation of the third edition, under the title "Atomic Structure and Spectral Lines," appeared in 1924.

A DEPUTATION from the Universities of Cambridge and Edinburgh was recently received by the Colonial Secretary with reference to the inauguration of an Imperial Forest Research Institute at the University of Oxford, combined with a fourth year's course in forestry. This project had been recommended by the Empire Forestry Conference which met in London in 1920. Few members of that Conference had full knowledge of the great progress made in forestry education at Cambridge and Edinburgh as the result of a recommendation of the Commission appointed in 1908 by the India Office after the closure of Cooper's Hill. That Commission invited these universities to inaugurate and equip schools of forestry, pointing out that competition would be to the benefit of forestry. At both universities forestry education up to a fourth year's post-graduate honours course was instituted Only the Colonial Office and the Forestry Commission took up the recommendations of 1920 and provided the funds with which the Institute and fourth year's work were started at Oxford, provisionally for five years, in October 1924. In selecting candidates for employment, from men with a degree or diploma in forestry, these two departments make an allowance to the chosen probationers and insist on their proceeding to Oxford to take the fourth year's course. The deputation pointed out the hardship thus incurred by men having to change their universities and, in the case of Edinburgh, to incur a far greater expense. In the opinion of the delegation, the innovation would result in a decrease in a good type of man coming forward to take forestry as a career.

A PAPER on the applications of electricity to agriculture by Mr. Borlase Matthews was read and discussed at the Institution of Electrical Engineers on March 4. He succeeded in proving many useful and convenient applications of electricity in connexion with farming. In his opinion, when a quarter of the area near a transmission line is arable land, the supply will prove profitable to the electric company. A specification is given of the author's electric tractor suitable for small farms. It is designed for ploughing, general haulage, and many other field operations. When carrying out field work, the machine takes its supply of current from an overhead wire and a cable laid on the ground. It has a 'half creeper' track so that it can go over rough ground. It also has a storage battery, so that it can proceed from field to field as well as haul loads on the public road It seems possible that the plough may be replaced by the rotary tiller, which has many points in its favour. This machine is excellently adapted for an electric drive, and the latest type of instrument buries the weeds and leaves, a result desired by most farmers. From the financial point of view, however, a strong case was not made out. Ploughing only takes place over a limited period of the year, and so it does not offer that uniform load desired by electric companies. Mr. Matthews' electric tractor, however, offers possibilities which should be further explored.

SIR HENRY MAYBURY, Director-General of Roads Department, Ministry of Transport, in his discourse on "London Traffic" at the Royal Institution on Friday evening, March 5, stated that the problem of the transport facilities of the great Metropolis cannot be solved unless it be approached on scientific lines. In 1903 a Royal Commission was appointed to inquire into the question, and made recommendations for improvements to which effect was never given. Another Royal Commission was appointed in 1921, and the outcome of its recommendations was the passing of the London Traffic Act in 1924, and the appointment, under the Minister of Transport, of the London and Home Counties Traffic Advisory Committee. This Committee has made a thorough investigation of the various tramways and omnibus routes, and is required to supervise an area within a circle extending about 25 miles from Charing Cross. The engineering staff of the Committee has given much attention to the bridge question in the traffic area, and is making a report thereon. The results of the Committee's recommendation have been so far successful in the adoption of the gyratory or continuous working arrangement as now in operation at the end of Parliament Street, Bridge Street, and near the Victoria Memorial; and schemes of identical character have been approved for Trafalgar Square and Hyde Park Corner. By utilising many of the existing subsidiary roads, which may be made continuous and through routes, and by the use of effective direction signs by day and night, it is believed that with much advantage a large amount of traffic can be deflected. The Committee is proceeding with negotiations with the various local authorities, in order to find a satisfactory solution to the vast problem of London traffic, which is of so much importance to the comfort, health, and general welfare of the citizens of London.

SEVERAL valuable papers on power-plant design and operation were read and discussed at the December meeting of the American Society of Mechanical Engineers held in New York. These papers are of special interest in Great Britain at the present time. In the United States cheap overhead lines are permitted, and this leads to the building of super-power stations. As the cost of labour is high, this also accentuates the economies effected by their use. Mr. C. W. E. Clarke describes the rapid advances made by the Colfax station of the Duquesne Light Company. It began to operate in 1920 with a turbo-alternator generating 60,000 kilowatts. The steam pressure used was 275 lb. per square inch and its temperature was 600° F. In 1923 it was decided to use pulverised fuel and to raise the steam temperature to 650° F., preheated air being supplied to the furnaces. It was found, however, that the bricks lining the furnaces were apt to be fluxed at this temperature In the newer boilers the furnaces are water lined and no trouble has been experienced. The boilers cost 16 per cent. of the total cost of the station, and the turbines and electric generators practically cost the same. The steam pressures used are rapidly increasing. American makers are prepared to supply boilers for a working pressure of 1200 lb. per square inch. Turbine makers, however, are unwilling to go beyond a pressure of 600 lb. Their problem, being a dynamical one, is more difficult than the statical problem of the boiler makers. It is stated that the cost of a boiler to work at a pressure of 1000 lb. is about twice as great as that of a boiler for a pressure of 200 lb. per square inch. As yet there is no British station working at a pressure much in excess of 500 lb. per square inch. Sir James Kemnal recently suggested that, with very high pressures, steam drums should be drawn solid and not riveted as they are at present.

MOUNT SINAI has been considered as a site for a third Smithsonian station to study fluctuations of the sun's light and heat, but it has now been abandoned as a possibility. Dr. C. G. Abbot, Assistant Secretary of the Smithsonian Institution of Washington, D C., and Director of the Smithsonian Astrophysical Observatory, has left the Red Sea and finished his tour of India. He is now on his way to South Africa, continuing his search for a suitable site. It is hoped that data obtained from a third station, and later from a fourth, if more funds should become available, will increase the possibility of making trustworthy weather forecasts all over the world, weeks and even months in advance. Data are already being obtained from the study of the sun at Mt. Montezuma on the western slope of the Andes Mountains in Chile, and on Table Mountain in Southern California; and the National Geographic Society has made a third observation station possible by extending financial aid

PROF. FRASER HARRIS, formerly lecturer on physiology in the University of Birmingham, delivered the last of the present series of Monday evening lectures at the Midland Institute on March 8. His subject was "Biology in Shakespeare." Prof. Fraser Harris said that he used the word biology as meaning all knowledge concerning life, vegetable and animal, both in health and disease; but for the purposes of the lecture, he would not include any references to botany, zoology, or medicine. He did, however, include one or two allusions to surgery, the most interesting of which were the lines spoken by the Archbishop of York in "Henry IV.":

> "If we do now make our atonement well,
> Our peace will, like a broken limb united,
> Grow stronger for the breaking."

References to the physiology of the following were studied in the plays—sleep, the heart, arteries, veins, and nerves; fainting, the doctrine of the three kinds of spirits, the halitus sanguinis; the action of alcohol; digestion; starvation; the description of Falstaff's death; infection; first aid; the vis medicatrix naturæ; the pia mater and the visceral distribution of the emotions. The physiological psychology of visual hallucination; trophism of nerves, sense before motion; retinal fatigue; the Sauson images; giddiness; psychical blindness and paraphasia were also illustrated by references from the plays.

THE anxiously awaited report of the Broadcasting Committee under the chairmanship of Lord Crawford and Balcarres was issued late last week (H.M.S.O., Cmd. 2599, price 6*d*.). The terms of reference were "To advise as to the proper scope of the broadcasting service and as to the management, control, and finance thereof after the expiry of the existing licence on December 31, 1926. The Committee will indicate what changes in the law, if any, are desirable in the interests of the broadcasting service." The Committee recommends that after the end of this year, the broadcasting service in Great Britain should be in the hands of a public corporation to be known as the British Broadcasting Corporation, consisting of not more than seven or less than five commissioners nominated by the Crown. These commissioners should be persons of judgment and independence and free of commitments; they should receive adequate remuneration. Advisory committees would be appointed by the commissioners in consultation with appropriate societies and organisations, so that all phases of broadcasting may receive consideration. As regards research, the Committee states that expenditure will govern progress: "Outlay on bold experiment should not be meagre. Research should be constant, both official and unofficial." The Committee was much impressed by the evidence received on the importance of broadcasting in education in its widest sense, and advocates the extension of such facilities, if necessary, by the introduction of special wave-lengths for definite subjects.

FEBRUARY temperature was a record in England, and the observations at Greenwich Observatory published in the Daily Weather Reports of the Meteorological Office and in the Weekly Returns of the Registrar-General show some exceptional results. The mean air temperature for the month at Greenwich was 45°·7 F., which is the highest mean for London or Greenwich in February during the last 156 years, it is 6°·9 above the monthly normal for the 150 years from 1770 to 1919, and in practical agreement with the normal for April. In this long series of years the February mean for 1869 was approximately in agreement with that for 1926, and the only other means of 45° or above were 45°·3 in 1779 and 45°·1 in 1872. There were two days, February 21 and 26, with the shade temperature above 60°, and there were eleven days with the temperature above 55°, there were eight days with the temperature for the 24 hours 10° or more in excess of the normal, while the only days with the temperature below the normal were February 9 to 14. The minimum or night temperature was above 40° on seventeen nights, and there were only two nights, February 13 and 14, with frost in the shade. On two days, February 22 and 26, the black bulb thermometer in the sun's rays exceeded 100°, the respective readings being 106° and 111°, but the duration of bright sunshine for the month was small, registering only 1·3 hours a day on the average, while the normal is 2·0 hours Separating the mean of 150 years into periods of 50 years, the means at Greenwich for February are 38°·1 for 1770–1819, 39°·0 for 1820–69, 39°·4 for 1870–1919; the mean for the 150 years is 38°·8. The normal for 35 years, 1880–1915, in general use by the Meteorological Office is 39°·8.

ACCORDING to the *Weekly News Bulletin* issued by the U.S.S.R. Society of Cultural Relations with Foreign Countries, preparations are being made for the celebration of the eightieth birthday of Dr. A. P. Karpinsky, who has been a member of the Academy of Sciences for forty years and its president for the past ten years.

BESIDES the earthquake felt at Comrie at 4·24 A.M. on February 21 (NATURE, March 6, p. 355), it is now stated that a second and perhaps slightly stronger tremor occurred at about 7·40 P.M. on the following day. Both were felt at Lawers, two miles east of Comrie, and at St. Fillans, four miles to the west. The epicentres probably lie about a mile to the west or north-west of Comrie, and close to those of the remarkable series of earthquakes in 1839 and the following years, thus showing a slight displacement to the west since the shocks of 1895 and 1898

THE discovery has been announced, by the New York correspondent of the *Times*, of the element of atomic number 61, by Dr. B. S. Hopkins and others, of the University of Illinois, apparently by the use of X-ray methods. The full account of the work will be awaited with much interest, for element No. 61 belongs to the group of 'rare earths,' the separation of which has always been unusually difficult owing to the close resemblance in properties of the individual elements. On the evidence of high-frequency spectra, it has been shown that the group consists of fourteen elements ranging from lanthanum (At. No. 57) to lutecium (At. No. 71), with a gap represented by element No. 61. Prof Hopkins' discovery would apparently complete the group.

AT a meeting held at the Institution of Civil Engineers on March 5, the organisation of a body to deal with questions of fuel technology was discussed. The proceedings were opened by Sir William J. Larke, of the National Federation of Iron and Steel Manufacturers, who referred to the widely divergent character of fuel practice in industry, and emphasised the need for a body aiming at co-ordination of existing knowledge on the subject. Sir Philip Dawson stated that the fuel bill is a dominant factor in industry; it forms 35 per cent of the production costs in the iron and steel industry; 50 per cent. in the generation of electricity; and 30-45 per cent. of locomotive costs on railways. Sir Richard Redmayne also supported the suggestion for the organisation of an institution of fuel technology, and a committee was appointed to discuss preliminaries and to decide the question of collaboration with the Institution of Fuel Economy Engineers.

IN 1922 the staff of the Research Laboratories of the General Electric Co. Ltd , Wembley, decided that in making communications in scientific journals, the most appropriate method of recognising the co-operative conditions under which their research work is conducted was by expressing authorship as in the name of the whole of the staff Mr. C. C. Paterson, Director of the Laboratories, now informs us that this formula has been misunderstood, and objections have been urged against it even by those who agree with it in principle. A change is therefore to be made, and the formula " by . . . (Communication from the Staff of the Research Laboratories of the General Electric Company, Wembley) " has been selected

THE Council of the Institution of Mining and Metallurgy has made the following awards: The gold medal of the Institution to Sir Robert N. Kotzé, Government mining engineer for the Union of South Africa, in recognition of his distinguished services to the mining industry, with special reference to his work on the dust problem in the mines of the Rand, and of his public work in promoting the development of the natural resources of the Union of South Africa; " The Consolidated Gold Fields of South Africa, Ltd." gold medal to Prof. L. H. Cooke, in recognition of his services, extending over many years, in the advancement of the science and practice of mine-surveying and the improvement of surveying instruments, and of his valuable contributions to the literature on the subject; " The Consolidated Gold Fields of South Africa, Ltd." premium of forty guineas to Dr. H. C. Boydell for his paper on " The Rôle of Colloidal Solutions in the Formation of Mineral Deposits "

THE Geological Society of Peru, which was founded at Lima in July 1924, has issued the first volume of its *Boletin*. The report of the second meeting includes a speech by the President of the Republic, who attended to express his sense of the value of a geological society to a country so rich in mines as Peru. The first printed paper, on some fossil shells from the Cretaceous and Eocene of Peru, is by the president of the Society, Dr. C I. Lissón, professor of geology in the School of Engineers of Lima. He also writes at length on the palæogeography of Peru, and publishes a series of maps of the country at successive geological periods. Among other papers on Peruvian geology may be specially mentioned a valuable summary of the deposits yielding petroleum, by Mr. R. A. Deustua. The publication is well printed and illustrated, and shows that the Society has made a good beginning. To our congratulations we would add our best wishes for its continued success

THE United States Department of Agriculture Library has recently issued an author and subject index covering the publications of the Department of Agriculture on plant pathology up to January 1, 1925, exclusive of the publications on the diseases caused by insects. In the author arrangement all anonymous and some ephemeral publications have been omitted. The subject index aims at giving a complete record of the publications of the Department on plant pathology. Some selection has been made for subjects upon which there are many contributions, the brief and less important ones being omitted. For subjects on which there are few publications, all have been included. The index covers 158 pages of close type-script, a preliminary account being given of the various series of reports and bulletins that are dealt with. Some of the more recent papers are now available for free distribution, and many of the others may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D.C., though most of the early series are entirely exhausted. The Library of the Bureau of Plant Industry is interested in establishing exchange relations with other institutions which issue publications on plant pathology and other subjects pertaining to the work of the Bureau.

A COMPACT and ingenious soil testing outfit has just been put on the market by the British Drug Houses, and should prove of considerable value to farmers and research workers who may need to get a rapid indication of acidity or alkalinity in field soils. The outfit consists of a small double-chambered porcelain boat, a porcelain spatula, and a dropping bottle of B.D.H. soil indicator. The soil and indicator are carefully mixed in the larger end of the boat, allowed to settle and the supernatant liquid decanted into the smaller end, where the colour may be observed readily. The colours range from red with a very acid soil, through orange and yellow, to green in a neutral soil, while alkalinity is shown by blue. The first three colours indicate that lime is needed to improve the fertility of the soil. Tests made with the outfit show that it is practical in type, is easily worked, and that the colour differences are clear and sharp, making it specially useful to observers who are not experienced in the manipulation of scientific apparatus.

MESSRS. Ogilvy and Co. have sent us the third edition of the pamphlet on how to use the microtome, prepared by Prof. S Becher of Giessen, which is issued by Messrs. Leitz. It is an eminently practical compendium which describes clearly how to imbed tissues in paraffin and celloidin and how to use the various forms of microtomes made by Leitz; and most microtomists will probably find in it some small points which they have not heard of or have forgotten. To beginners it should certainly be useful. The only serious defect is that it does not mention the Cambridge rocking microtome, the practical excellence of which seems scarcely to be realised outside Great Britain. Fixation and staining are dealt with only incidentally, but we note that Prof. Becher thinks highly of some nuclear stains (naphtopurpurin, etc.) which are not well known here. The translation is quite clear if not always idiomatic: for English readers reference should have been made to Lee and Gatenby's "Microtomists' Vade-Mecum" rather than its collateral, P. Mayer's "Zoomikrotechnik."

MESSRS. W. Watson and Sons, Limited, 313 High Holborn, London, W.C.1, have recently issued a catalogue of optical and other scientific instruments, with which is combined a dictionary. The latter contains all the descriptions and illustrations included in the "Dictionary of British Scientific Instruments," issued by the British Optical Instrument Manufacturers' Association, and referred to in our columns (NATURE, May 12, 1921, pp. 324-5) shortly after its publication. The combined catalogue and dictionary forms a work of reference which should be of great value and interest to the users of scientific apparatus. The catalogue contains a typical selection of instruments manufactured or supplied by Messrs. Watson. These cover a very wide range and include magnifiers and microscopes, telescopes and field glasses, optical projection apparatus, nautical and meteorological instruments, drawing and surveying apparatus. Among the newer instruments is the 'Binar' pocket combined telescope and magnifier. This consists of an achromatised object glass and a focussing eyepiece, and gives a magnification of 2½ diameters. The object glass alone can be used as a magnifier of about 6 diameters. The telescope is of such small dimensions that it can easily be carried in the waistcoat pocket. The 'Window' telescope is a lens of 15 in. diameter which can be placed in contact with the glass of a window. By its means, observers within a room may conveniently obtain a magnified image of distant objects visible from the window, and thereby the attractions of a house with a pleasing outlook become enhanced.

READERS interested in books relating to the Near East and Egypt should obtain Catalogue No. 476 of Mr. F. Edwards, 83a High Street, Marylebone, W.1, which gives particulars of nearly 900 works concerning Egypt, Mesopotamia, Arabia, Palestine, Asia Minor, the Balkan States, the Sudan, etc.

THE latest catalogue (No. 265) of Messrs. W. Heffer and Son, Ltd., Cambridge, contains the titles of some 1600 books and journals relating to mathematics, physics, astronomy, chemistry, and chemical technology. It should be useful to those requiring publications in the sciences named; also for reference.

MESSRS. C. BAKER, 244 High Holborn, London, W.C.1, have sent us a new issue of their well-known classified catalogue of second-hand scientific instruments. It contains a noteworthy collection of physical and related apparatus, and in particular there is a large number of student's microscopes and accessories. A special catalogue of this section can be obtained post free on application.

MESSRS. Crosby Lockwood and Son announce "The Science of Flight and Practical application," 2 vols., by Capt. P. H. Sumner. The work will be a study of the principles of flight and practical aircraft. Vol. 1, dealing with airships and kite balloons, will be published shortly. The same publishers will also issue "Hydrology," by J. M. Lacey, treating of rainfall and the influence of its distribution on the earth.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Two junior engineers at the Forest Products Research Laboratory, South Farnborough, Hants—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (March 20). A senior technical assistant for experimental work at Greenock in connexion with high-speed internal combustion engines of a special type—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (March 20). A number of assistant electrical engineers in the Admiralty Service—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (March 20). A head of the Engineering (Production) Department of the Joint Technical College under the Wolverhampton and Staffordshire Education Committees—The Director of Education for Wolverhampton, Wolverhampton (March 20). A senior botany mistress at James Allen's Girls' School, East Dulwich Grove, S.E.22—The Headmistress (March 30). A physiological botanist and a biochemist under the Government of Madras (Development Department), for research work on cotton—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (April 1). A pathologist under the Manchester Committee on Cancer—The Chairman, Manchester Committee on Cancer, 1 Mount Street, Manchester (April 3). A professor of physics in the University College of South Wales and Monmouthshire—The Registrar, Cathays Park, Cardiff (April 17). A warden of the College House of Bedford College for Women—The Secretary, Bedford College for Women, Regent's Park, N.W.1 (April 30). An assistant in the department of entomology (Division of Tropical Medicine and Hygiene), London School of Hygiene and Tropical Medicine—The Secretary, 23 Endsleigh Gardens, W.C.1 (May 31). A chemical laboratory assistant in the Experimental Department of the Fine Cotton Spinners' and Doublers' Association—F. P. Slater, Rock Bank, Bollington, near Macclesfield. A teacher of engineering subjects at the Wandsworth Technical Institute—The Principal.

Our Astronomical Column.

RECENT MAGNETIC DISTURBANCE.—A magnetic disturbance was recorded at Greenwich on March 5, commencing at 10 hr. and lasting until 6 hr. on the following morning. The most disturbed part of the magnetograph traces was between 16 hr. and 23 hr. on March 5, when the extreme range in declination amounted to 53′. The disturbance is thus somewhat inferior to those commencing on January 26 and February 23, but is of interest on account of its apparent connexion with a large sunspot in solar latitude 27° south, mentioned in NATURE of March 6, p. 356. The magnetic disturbance began when the spot was 21° or 1·6 days west of the sun's central meridian.

ENSOR'S COMET.—The absence of any reports of European observations of this comet is cause for surprise. It was easily seen at Johannesburg in bright twilight towards the end of January, and it should have been equally bright early in March. The morning sky has been generally cloudy in England, but Dr. W. H. Steavenson utilised a clear interval on the morning of March 5 to search for it; he found no cometary object as bright as magnitude 9 within 30′ of the tabular place. Assuming that no error was made in setting, this would indicate a very unexpected decline in light. This would not be unprecedented; Westphal's comet underwent a similar mysterious loss of light in the autumn of 1913. Further observations are desirable before the fact is regarded as established. Mr. G. Merton noted that the comet approached Mercury within a tenth of a unit about February 11. The mass of Mercury is, however, too small to produce any appreciable disturbance at this distance.

THE MEASUREMENT OF STELLAR RADIATION.—An interesting article by Dr. Hale on "Heat from the Stars" is published in *Scribner's Magazine* for January. After an historical introduction, the work of the late Prof. Nichols with the radiometer is described, and an amusing reminder of the great sensitiveness even of his early type of radiometer is afforded by the remark that the observed deflexion due to the heat radiation from a human head 2000 feet distant was as much as 25 millimetres. Work with thermo-couples by Pfund, Coblentz, and Pettit and Nicholson is next described: the sensitiveness of the instrument used by the two latter observers being so great that the radiation from stars even so faint as the thirteenth magnitude has been measured. Finally, after an account of Abbot's work on the energy distribution in stellar spectra, Dr. Hale explains the relation between facts obtained in the manner described and theories of stellar constitution and life-history, as exemplified by the work of Eddington and Jeans. The article is well illustrated and interestingly written for the general reader, forming a useful summary of the work accomplished up to the present time in this department of astronomy.

NOVA PICTORIS.—*Astr. Nach.*, No. 5413, contains an interesting paper on this star by Prof. J. Hartmann of the La Plata Observatory. The position is given as R.A. $6^h\ 34^m\ 56^s{\cdot}58$, S. Decl. $62°\ 34'\ 32''{\cdot}7$ (equinox 1925·0). Magnitudes of the star are tabulated from 1925, May 27 (mag. 2·8) to Nov. 23 (mag. 4·4). The principal maximum (mag. 0·96) was on June 9; there were secondary maxima on July 28 (mag. 1·8) and Aug. 10 (mag. 2·3). The star remained conspicuously visible to the naked eye for more than seven months, which is longer than the duration of most recent novæ.

Prof. Hartmann elaborates a new theory of novæ; a great increase of temperature is supposed to arise in the star's central regions, causing a rapid expansion of the surface. In the present case the radial velocity due to this expansion was found to average 140 km./sec. The star's radius prior to the outburst is estimated as 1,400,000 km.; on May 27 this had increased to 141,000,000 km., and on June 9 to 298,000,000 km. Throughout the expansion the surface temperature is assumed to remain unaltered, but after the maximum, cooling sets in and the spectral type changes. Taking the star's original spectral type as A 2, its parallax is found to be 0·0007″, and distance 4500 light-years.

Prof. Hartmann notes that a change of surface temperature from the coolest to the hottest stellar type would account for only one-tenth of the increase of light, so that increase of diameter is also required.

Research Items.

Origin of the Eskimo.—Writing on the results of the fifth *Thule* Expedition, 1921–24, in the *Geographical Journal* for February, Mr. K. Rasmussen believes that the original Eskimo culture must have been of an exclusively inland type, that of a people dwelling by lake or stream. In course of time, either by following the wandering reindeer or driven by hostile Indian tribes, the aboriginal Eskimo moved to the Arctic shores, adapting their implements to the needs of hunting in the sea and on the ice. Reindeer appear to have led them to the region between Coronation Gulf and Boothia peninsula. From there they moved west to Alaska and east to Greenland. The belt of tundra west of Hudson Bay barred the passage of one large group now known as the Caribou Eskimo, among whom the aboriginal inland culture has been preserved. The Eskimo who moved to the coast evidently flourished, and hence their extensive migration west and east. Finally, in comparatively recent times, a new migration has taken place from the interior down to the coasts. These conclusions are in close accordance with the views first advanced many years ago by Prof. Steensby. The papers contain a summary of the main results of the expedition and has several photographs of the Caribou Eskimo.

Spirit Worship in the Nilgiris.—In the *Indian Antiquary* for January, Rai Bahadur B. A. Gupte gives an account of a curious family of 'Pariahs,' who lived in the Nilgiri Hills about twenty years ago, two of the members of which were said to be spirit-possessed, and to have certain powers. Not only did they profess to foretell the future, but they also claimed to be able to ward off calamities, exorcise demons, give children to the barren, and regulate the sex of unborn children. Their influence was so great that although 'untouchables,' Brahmans and their womankind mixed with them freely. The possessed members were the younger son and younger daughter, the former by Mariamma, the goddess of cholera, and the latter by Kani-amma, the virgin goddess. Mariamma, ferocious and wild, was represented as a widow who guided Kani-amma, who was fair, young, and attractive. A small hut was set out as a shrine of Mariamma, who was represented by a small stone figure about 9 inches high. The author witnessed several performances by the family in one of which the goddess, speaking through the girl, answered questions propounded by him; in another the son as 'god' went through a dancing performance in the course of which he stood on the edge of a scythe. No mention is made of the more violent symptoms usual in 'possessions.'

Geography of Wisconsin.—Wisconsin has an active Geological and Natural History Survey which has been responsible for several memoirs on the State. The latest of these is a well-illustrated volume, published by the State at Madison, on the geography of south-western Wisconsin (Bulletin No. 65), by Mr. W. O. Blanchard. The various geographical factors of topography, soil, climate, mineral resources, and position are treated in turn by an author with a wide personal knowledge of the country. The result is a lucid explanation of the past and present economic conditions and distribution of population. Another publication by the same society (Bulletin No. 67) is a brief outline of the geography of the whole State by Mr. W. O. Hotchkiss and Mr. E. F. Bean. This is written in a more popular style, but forms a useful summary.

Prenatal Death and Sex Ratio in the Pig.—Dr. F. A. E. Crew (*Proc. R. Soc. Edin.*, vol 46, pt. 1) finds that the primary sex ratio in pigs is at least 60 per cent., 150 males to every 100 females being produced as a result of fertilisation, due either to a differential production of the two sorts of spermatozoa or a differential functional activity on the part of these. There is a serious prenatal mortality affecting chiefly the males and operating in such a way as to make the secondary sex ratio practically equality. The reason for this higher male death-rate the author believes to be fundamentally genetic in its nature, and suggests that the male type of physiology is less able to withstand the stress of functioning both prenatally and postnatally than is the female. His results confirm those arrived at by Parkes in a similar inquiry.

Asymmetry in Mammalian Skulls.—Mr. A. B. Howell (*Proc. U.S. Nat. Mus.*, vol. 67, art. 27) has investigated very thoroughly four mammal skulls which exhibit definite asymmetry, two primates and two pinnipedes. From his examination of this material the author concludes that the primary cause inducing asymmetry in the skulls of mammals is probably accident or disease to the bones or muscles of one side of the head at an early age, of such a character as to result in a stunted or infantile condition of a crucial part of the bony framework and a reduction in the rate of growth, or strength, through lesions, of the corresponding muscles. The normal development of the bones of the skull is directly dependent upon the growth of the attached muscles. If the latter for some reason or another remain infantile or fail to grow, the bones to which they are attached will remain proportionally undersized. In the four skulls examined, the original seat of the injury was in the neighbourhood of one of the glenoid fossæ, and the author discusses the relations of the temporal and masseter muscles in their size and strength with the extent of the asymmetry observed in the skulls.

The Vascular System of the Myxinoids.—Prof. F. J. Cole has continued his systematic study on the myxinoid fishes, and in pt. vi. (*Trans. Roy. Soc. Edin.*, vol. 59, pt. ii., 1925) of his monograph presents a detailed and excellent account of the vascular system of Myxine. Many important new features are brought out. Asymmetry of the veins is of constant occurrence, with the result that vessels which are not homologous perform the same functions on the two sides of the body. A third pair of local hearts is described in relation to the cardinal veins, in addition to the previously known unpaired portal and paired caudal hearts. The cardinal hearts are sacs formed by swellings of the veins in question, guarded by valves, and possessing extrinsic structurally modified muscles. In the possession of an extensive lacunar system, myxinoids are specialised, and a complete account of this system is now available for the first time. These lacunæ are lined by endothelium and are divisible into red and white lymphatics. The former always contain red blood which enters them from the arteries, and they also communicate with the veins by valved apertures. They form, therefore, part of the blood vascular system interposed between the arteries and veins and take the place of a closed capillary system, which is absent in those regions where these lymphatics occur. The dominating feature of this system is an extensive subcutaneous sinus, so that the animal lies in its skin as in a loose sac. The white lymphatics represent a true lymphatic system corresponding to that of higher vertebrates. It forms a complete system in itself, beginning as a blind plexus in the walls of certain organs and discharging finally into the veins, indirectly through the red lymphatics, and also directly via the caudal hearts.

Snow in Eastern Siberia.—To the *Recueil de Géophysique* (vol. 4, pt. 3) of the Geophysical Observatory of Leningrad, M. W. B. Shostakovitch contributes a statistical paper on the snow covering of eastern Siberia since 1881, when regular observations were first made, until 1913. The data, while showing a distinct correlation between the thickness of the snow covering and the quantity of winter precipitation, prove that various factors have importance. Topographical features have great influence; on windward slopes the snow cover is greater and on leeward slopes less than the precipitation would suggest. Most interesting, however, is the conclusion that the annual variation in thickness of the snow cover is especially great in regions where snow is comparatively scarce. February is the month of maximum thickness, the depth of snow in that month averaging 10 cm. to 20 cm. in the Amur valley, except at the mouth, where it rises to 70 cm., and increasing generally towards the north-west and north-east but keeping comparatively shallow in the Okhotsk district and Lena valley. Practically the whole of eastern Siberia, except the east coast, has a snow covering for at least 150 days a year, the duration increasing with latitude to 250 days.

Isostasy in Western Siberia.—In 1912 the Russian Astronomical Society sent an expedition to Western Siberia to determine the force of gravity at various stations. From the results obtained, isostatic reductions have now been made by Wm. Bowie and his co-workers (*Am. Journ. Sci.*, Feb. 1926, p. 113). The remaining anomalies are very small, and provide further support for the view that isostasy obtains for all portions of the earth's crust. The data for Siberia and for other regions are conveniently summarised in a table, part of which is here reproduced. The figures refer to the number of gravity stations and to the mean anomaly in dynes with regard to sign.

United States	296	−0·006
Southern Canada	42	−0·009
Northern Canada	9	+0·001
India	73	−0·004
Holland	51	−0·001
Alps and vicinity	31	+0·019
Western Siberia	9	−0·005
To these may be added,		
Southern Pacific Islands	5	+0·030

This last result should probably be reduced by one-half to take into consideration the much higher density of Pacific as compared with continental rocks (*Journ. Wash. Acad. Sci.*, Dec. 4, 1925).

Echo Soundings in the Indian Ocean.—In the waters to the south of Java and Bali and around Christmas Island, where soundings hitherto have not been numerous, several hundred echo soundings were taken last autumn from four Dutch submarines and the depôt ship *Pelikaan*. An account of the work with a chart of the waters is published in *Verhandelingen* No. 17 of the Royal Observatory of Batavia. The instruments used were those generally employed for submarine communication between vessels. Several observations being made for each determination, the time error was reduced to about 0·1 second. The few previous soundings on the whole agree with the echo soundings; occasional discrepancies may be due to inaccuracies in the geographical positions of the earlier work. The regularity of the submarine contours in a region with great differences in depth suggests the reliability of the echo work. A remarkable result is the discovery of a row of submarine elevations in about lat. 11° S., or more or less in a line with Christmas Island, and immediately to the north of them a long steep-sided trough of more than 3800 fathoms and reaching in one place to 4107 fathoms.

The Determination of the Wave-lengths of X-rays by Means of a Reflection Grating.—Doan and Compton have recently observed the diffraction of X-rays falling on a metallic grating at a very small angle with the surface, and, in the *Comptes Rendus Acad. Sci.*, Paris, January 4, M. J. Thibaud describes measurements made on the $K\alpha$ and $K\beta$ copper rays, using a plane glass grating with 200 lines per mm. with a width of less than 4 mm. The angle between the rays and the surface of the grating was less than the limiting angle for total reflection, and the photographic plates showed two broad stripes corresponding to the direct and the totally reflected rays, and a diffraction spectrum with remarkably fine lines. The wave-length for the line $K\alpha$ Cu was determined as $\lambda = 1{\cdot}540$ Å U, correct to about 1 per cent., while measurements on diffraction in crystals, using the accepted values for their lattice constants, give 1·538 Å. The Compton effect did not appear to influence the result, and theory shows that any such influence would be extremely minute for the angles employed.

A New X-ray Spectrograph.—At the meeting of German physicists in Danzig in September 1925, Dr. H. Seeman of Freiburg described a new X-ray spectrograph without a circular scale, which allowed its zero point to be accurately determined, did not depend on focussing, and could be used with crystal surfaces far from perfect. His paper appears in the issue of the *Physikalische Zeitschrift* for January 21. The camera holding the plate on which the diffraction photograph is taken is bounded on one side by a plane surface at right angles to the plate. On this plane surface a bridge-piece, in the centre of which the crystal is fastened, can slide. The surface of the crystal is adjusted to be nearly parallel to the plane surface. In front of the surface of the crystal is a knife edge, the distance of which from the crystal can be adjusted. The X-rays fall on the crystal at an angle of 10°-20° to the surface, and the knife edge prevents their direct access to the plate. Two photographs are taken, the crystal being rotated through 180° about an axis perpendicular to the plane side of the camera by moving the bridge on the plane. A wider beam is used in determining the zero. The author describes two other methods of using the camera: one, which he calls the 'pin-hole camera,' suitable for all X-rays, and the other a transmission method suitable for thin crystals and X-rays they do not absorb.

Fibrous Crystals of Sodium Chloride.—We have received a communication from Mr. L. McCulloch, of the Research Department of the Westinghouse Electric and Manufacturing Co., Pittsburgh, in which he refers to the statement by Ruskin, quoted by Prof. Desch in his British Association address on the chemistry of solids (see Nature, Oct. 24, 1925, p. 610), to the effect that whilst red cuprous oxide may sometimes form fine hair-like threads, sodium chloride and other cubic minerals never assume such a form, the statement being used to illustrate the imperfection of our knowledge of the cause of variations of habit among minerals. Mr. McCulloch sends photographs of columnar or fibrous crystals of sodium chloride, obtained by growth in an acid gel prepared by mixing a solution of sodium silicate with hydrochloric acid. These crystals are slender rods, several millimetres long, with cubic terminations. Such crystals have been prepared on several occasions, one of the earliest records being that of A. Knop, who records hair-like crystals of potassium chloride in his "Molekularconstitution und Wachstum der Krystalle" (1867), whilst others are recorded by O. Lehmann in his "Molekularphysik" (1889). The presence of gelatinous material favours elongated growths, and many observations of the kind are found scattered through the literature. One of the photographs shows curving and distortion of the rods, which is also characteristic of growths in gels.

SAMUEL HAHNEMANN AS A CHEMIST.—At the request of some of his medical friends, Prof. E. O. von Lippmann has investigated (*Chemiker-Zeitung*, 1926, Nos. 1 and 4) the chemical knowledge of Samuel Hahnemann, the founder of homœopathy. In books on the subject, Hahnemann is often described as an accomplished chemist, and the investigations of von Lippmann show that the title is well deserved. So far as chemistry is concerned, Hahnemann was entirely self-taught, but he nevertheless made rapid progress, and was one of the first to realise that a training in chemistry is of the greatest importance to the medical student. In 1784 he undertook the production of a German edition of a work by Demachy (1728–1803), entitled "L'art du Destillateur des eaux fortes" (Paris, 1773), and called it "Der Laborant im grossen, oder die Kunst, die chemischen Produkte fabrikmassig zu verfertigen." This book, which is a kind of technological text-book of the most important chemical preparations, and is by no means concerned merely with acids, was enriched by Hahnemann with a large number of original contributions. Among these may be mentioned the detection of hydrochloric acid by means of silver sulphate, and of sulphuric acid with lead chloride; the estimation of sulphuric acid and other chemicals by means of specific gravity determinations; and a clear realisation of the importance of the newly-discovered 'fire-air' in the process of combustion. Hahnemann devised also a method of estimating arsenic by precipitating it in the form of its sulphide from a solution made weakly acid with hydrochloric acid, and gave the alternative method of precipitation with an ammoniacal solution of copper. About 1788 he invented the sulphuretted hydrogen test for the presence of lead in wine. Although Fourcroy had suggested the same test, he was not able to overcome the difficulty that iron might interfere with it, whereas Hahnemann showed that by making the wine weakly acid with spirit of salt, the iron would not be precipitated. Hahnemann carried out many more pieces of chemical research, notably an investigation of silver nitrate, and von Lippmann concludes that he possessed an uncommonly good knowledge of the science. It is noteworthy that, so early as 1792, he is described in Crell's "Annalen" as a celebrated analytical chemist.

THE ALGEBRAIC NUMBERS AND DIVISION.—In his presidential address to Section A of the American Association for the Advancement of Science at the recent Kansas City meeting, Dr. J. C. Fields, of the University of Toronto, lectured on "The Algebraic Numbers and Division." The modern theory of algebraic numbers had its origin about a hundred years ago in attempts to prove Fermat's last theorem, where a crucial difficulty arose through the discovery that an integer in an algebraic field is not, in general, uniquely expressible as a product of 'prime' integers in the field. Many attempts to extend the conception of an 'integer' in such a way as to restore uniqueness of factorisation were made by various writers, the matter being finally settled by Kronecker and Dedekind, whose definitions of an 'ideal,' the new entity required for the purpose in view, differed mainly in the matter of notation. More recently Hensel, in his "Theorie der Algebraischen Zahlen," has developed yet another method which has enabled him to obtain the most important known properties of algebraic numbers with remarkable ease. Hensel's method is based on the representation of a number r in the form

$$r \equiv a_i p^i + a_{i+1} p^{i+1} + \ . \ . \ . \ + a_k p^k \pmod{p^{k+1}},\ i \gtreqless 0,$$

where each coefficient a_s is chosen from the integers 0, 1, 2, . . . $p-1$. This p-adic representation holds not only for rational integers but also for rational fractions, and can be extended to apply to algebraic numbers too. In the application to algebraic numbers the general member of a field is taken to be $A_1\omega_1 + A_2\omega_2 + \ . \ . \ . \ + A_n\omega_n$, where A_1, A_2, . . . A_n are p-adic numbers and $(\omega_1, \omega_2, \ . \ . \ . \ \omega_n)$ a basis of the field. By this means Hensel has obtained a complete solution of the problem of resolving a prime number into its prime ideal factors. Most of Dr. Fields' address was devoted to the detailed technicalities involved in the p-adic representation of algebraic numbers. The case of a quadratic field was discussed more fully towards the end of the lecture.

ELECTRIC INDUCTION FURNACES.—The evolution of the electric furnace in which the refractory materials are heated by high-frequency induced currents, and some of the useful applications of this type of furnace, are well described by Dr. Northrup in a paper printed in the February issue of the *Journal of the Franklin Institute*. The earliest form of electric furnace used resistance heating. Then Moissan enclosed an electric arc in a box made of lime and succeeded in obtaining temperatures much higher than those obtained by other methods. He melted and reduced most of the refractory oxides, but unfortunately the resulting substances contained carbon and other impurities which were introduced by the vapours of the arc. In inductive heating, the radiated electromagnetic energy passing through the jacket of heat-insulating material falls on the conducting substance causing eddy currents which heat it. The heat-insulating refractory material used in the crucible is transparent to long-wave radiations but is nearly opaque to the short wave-length heat radiation. The heat thus rapidly accumulates and the temperature elevation becomes very high. With a frequency of 50, the ordinary frequency of supply in Great Britain, the magnetic field used must be very strong, and so iron has to be employed. But with frequencies of 500 or more, we get the 'ironless' inductive heater. At these high frequencies the condensers that have to be used in order that the ratio of the true power supplied to the apparent power may be large are very much smaller, and so their manufacture becomes commercially feasible. The method is specially applicable to very large installations. The Westinghouse Company make ingots of nickel-iron which are practically free from carbon and weigh 225 lb. There are a few gas holes in the ingots, but they are free from oxide and, as they weld together under forging operations, no metal is lost in trimming. Tantalum, which fuses at 2900° C., can be readily melted by the inductive method and produced practically free from carbon

Standards in Illumination and Photometry.

AT the meeting of the Illuminating Engineering Society held on February 25, a series of communications were presented reviewing recent British Engineering Standards Association's specifications dealing with illumination and photometry. Mr. P. Good, in an introductory paper, explained the aims and objects of the Association. In arranging for the preparation of standards, the Association does not act on its own initiative, but only on demands from outside; for example, from a representative trade organisation, a technical society, or a Government Department. When the British National Committee of the International Illumination Commission invited the Association to carry out standardisation in the field of illuminating engineering, a conference of all interested parties was called. The formation of a Sectional Illumination Committee was the immediate result of this conference, held in January 1924. This Committee is thoroughly representative, and the fact of many of its members being also members of other bodies or committees interested in illumination is favourable to co-operation and avoidance of overlapping of work. Specifications for portable photometers[1] and for industrial lighting fittings for electric lighting,[2] and a glossary of terms[3] used in illuminating engineering and photometry, have already been issued. Three other committees, concerned with illuminating glassware, street lighting, and photometric integrators, are actively at work but have not yet reported.

Papers summarising the three reports so far issued were then presented by the chairmen of the respective committees. Lieut.-Col. Edgcumbe, in dealing with the specification for portable photometers, pointed out that it opened new ground. Two broad classes of photometers are recognised: (*a*) for exterior work (for example, street lighting) where a range of 0·01 to 2 (or preferably 5) foot-candles is necessary, and (*b*) for interior use, where the range should be 0·2 to 20 foot-candles, or preferably higher. Provision for measurements of brightness as well as illumination is also desirable; the former should preferably be expressed in candles per square inch. The author discussed in some detail the nature of the test-screen, and the problem of obtaining a surface which would approach 'perfect diffusion,' and therefore have the same brightness when viewed at all angles. In practice it is found necessary to limit the angle of view, and the test-surface should be capable of being placed at least 4 ft. from the photometer and still fill the whole of the field of view. Other clauses prescribe the use of an ammeter to enable the current through the lamp in the instrument to be maintained constant, and the light from the lamp should have a colour similar to that of a metal filament lamp run at 9 lumens per watt. In conclusion, the various sources of errors in portable photometers were discussed, and it was shown that their additive effect may amount to so much as ±20 per cent. In practice, however, it is unlikely that all errors will be in the same direction, and therefore an all-round accuracy of ±15 per cent. seems a reasonable requirement.

Lieut.-Commdr. Haydn T. Harrison, dealing with the specification for industrial reflector fittings for electric lighting, explained that the main object is to standardise a form of reflector to assist the excellent work of the Home Office Departmental Committee in promoting improved lighting in factories and workshops. The most suitable type of reflector for this purpose appears to be the 'R.L.M.' form, having the following main features: (1) The source of light can be made invisible above a definite angle of cut-off, (2) at the angle where the filament is visible it is viewed against a highly illuminated white reflecting surface; and (3) the reflecting surface, being of vitreous enamel, is easily cleaned. If properly constructed and used, such reflectors should enable sufficient illumination to be provided without undue glare. But it is to be noted that the screening of filaments depends on the latter being in the correct position within the lamp bulb; hence the tolerances allowed in the B.E.S.A. specification for electric lamps are of importance. It was also pointed out that the adoption of forms of reflectors ensuring adequate screening naturally involves some increase in the absorption of light, and consequently a somewhat lower efficiency. Thus if the angle of cut-off be 20° instead of 17½°, as is customary in America, the efficiency may be only sixty per cent. as compared with seventy per cent. for the smaller angle. In comparing different forms of reflectors in terms of efficiency, due consideration must therefore be paid to the completeness with which the filament is screened from the eyes of operators.

The contribution dealing with the glossary of terms used in illuminating engineering and photometry was presented by Mr. P. Good, in the absence of the chairman of this committee (Mr. J. W. T. Walsh). The author directed attention to the stumbling-block of language in dealing with international affairs. Unfortunately the 'scientist-engineers' are apt to set up new towers of babel with every advance in knowledge. In illuminating engineering, the importance of common agreement on terms and definitions is very great. In reviewing the list, Mr. Good explained that it inevitably involves some degree of compromise, and it was shown that, whilst adhering to British methods, efforts have been made to bring the list into line with international and foreign practice. The first term (luminous flux) is fundamental. The term 'flux' to convey the notion of time has been so widely adopted that it appears to the committee preferable to substitute 'radiation.' Nevertheless, as 'luminous flux' has become such a familiar phrase in illuminating engineering, it was ultimately decided to retain it.

The three papers led to a keen discussion, in which Mr. C. C. Paterson (chairman), Lieut.-Col. Kenelm Edgcumbe, Mr. H. Buckley, Mr. G. Campbell, Mr. R. A. Ives, Lieut.-Col. Silvester Evans, Mr. H. C. Allpress, Mr. T. E. Ritchie, Mr. A. Cunnington, M. H. H. Long, Capt. W. J. Liberty, Dr. D. H. Ogley, Mr. L. Gaster, and others took part. The views expressed were generally favourable to the main conclusions of the specifications, though the exact application of the 'cut-off' angle in the case of industrial reflectors was the subject of some discussion. At the conclusion of the meeting a variety of reflectors designed to comply with the requirements of the specification were shown, and a number of portable photometers were exhibited. The latter included the most recent form of 'Holophane Lumeter,' in which various modifications to enable the instrument to comply completely with the specification have been embodied. A novel accessory shown for the first time was the test-plate fitted with a device to enable the angle of incidence of light-rays from the source to be determined. A very simple form of portable photometer recently developed in France (the 'Niam' photometer) was also shown.

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[1] British Standard Specification for Portable Photometers (No. 230–1925).

[2] British Standard Specification for Industrial Reflector Fittings for Electric Lighting (No. 232–1926).

[3] British Standard Glossary of Terms used in Illumination and Photometry (No. 233–1925).

Work of the Glass Research Association.

WE have recently received No. 14 of the Bulletin of the Glass Research Association, actually dated July 1925. The distribution of these copies to the press marks a departure from the practice of the Association, but there appear good reasons for so doing. The Association, when it found in 1924 that further Government financial assistance could not in the future be relied on, decided to wind up its activities, and it was clearly desirable that a résumé should be prepared, both for its members and for the scientific public, of the work which it had been able to accomplish. The copy of the Bulletin before us supplies this résumé, and we may add that it appears to have been done in a very efficient manner, the system of classification of the results adopted enabling the reader to grasp the facts readily.

The work of the Association was carried on in the laboratories of the Association itself and also in co-operation with the National Physical Laboratory, with the Department of Glass Technology, Sheffield, with two other research associations, namely, the British Refractories Research Association and the British Cast Iron Research Association, and, finally, in a single investigation on the subject of the efficiency of manual workers, with the Industrial Fatigue Research Board The National Physical Laboratory was responsible for several papers on the physical properties of glasses, covering the subjects of viscosity, thermal endurance, and elastic and viscous movements in glass. Special mention may be made of the researches on the viscosity of glass, since they covered a wide range of temperature and led to very interesting results.

Investigation of a whole series of problems of a fundamental character involving the processes of glass-melting were carried out at Sheffield, and results, important alike for practice and for theory, were the outcome. Of the work carried out in the laboratories of the Association, the one criticism that occurs to the present writer as he peruses the summary is that it covered so wide a range and appears to have involved so many ambitious programmes, that a number of investigations seemed to halt at intermediate post houses. Nevertheless, a great deal of useful information appears to have been passed on to the glass industry by the Association's workers.

We understand that most of the completed papers presented to the Association will eventually receive full and open publication, and there is no need, therefore, to examine the results of research in detail. The results so far obtained suggested to Research Committee A the direction in which future researches on glass might be planned, and a report signed by the chairman is appended to the Bulletin, suggesting to scientific workers that future investigations might be pursued on the subject of the constitution of glasses, using such methods as the determination of the viscosity, electrical properties or surface tension, the behaviour of glass under electrolysis over a wide range of temperature, a study of X-ray diffraction patterns and of heating and cooling curves obtained under various conditions. Other subjects needing investigation as having more or less direct practical application included the mechanical properties of glass in relation both to composition and to treatment, the thermal properties of glass at all temperatures up to the melting temperature, and the solubility of gases in glass at various temperatures and pressures, their mode of evolution and absorption and their effect on the physical properties of the glass.

A number of suggestions of a practical character are also appended in a note by the chairman of the Refractory Materials Research Committee.

Physical Factors in Mosquito Ecology.

IN the *Bulletin of Entomological Research*, vol. 16, pt. 3, pp. 187-248 (January 1926), Mr. R Senior-White contributes an important paper on this subject which should receive attention from all concerned with mosquito control. The author finds that, in Ceylon, natural waters exhibit a range of hydrogen ion concentration the *p*H values of which range from 5·4 to 9·2, but, as a general rule, mosquito larvæ only occurred when the *p*H was between 5·8 and 8·6. The *p*H was determined colorimetrically by means of Clark and Lubs' indicators. Species living in moving water have wider tolerances than those of standing water, and the former tolerate higher acidity, and the latter tolerate higher alkalinity, respectively. It also appears that anophelines have wider ranges of tolerance than culicines.

It is, however, less easy to generalise about mosquitoes breeding in artificial waters. Such waters are very diverse: there may be a coconut shell in deep shade, containing acetic acid as the result of fermentation, with water at *p*H 4·4; or there may be a water-butt in full sunlight, its contents green with algæ and giving a *p*H of 9·6+. Under such conditions mosquito larvæ, which are not to be found in natural waters, do occur. The commonest of the artificial-water breeders, *Stegomyia albopicta*, is found to tolerate water right through the entire range of *p*H values tested. The measurement of the "residual" *p*H, *e.g.* the value after bringing the water into gas-equilibrium with the air, is shown to be significant.

Natural-water breeding mosquitoes were thus found to be intolerant of any acidity other than that due to carbon dioxide. The solute-concentration limits were also inquired into and are summarised in terms of conductivity $\times 10^6$ in an accompanying table. Natural-water breeders are all found in water where this figure is below 1000, while artificial-water breeders extend their range into much higher concentrations. There appears to be no sharply limiting factor with respect to dissolved oxygen. In two species, with which a considerable number of observations were made, the data showed that there is a complete tolerance ranging from water with only 0·40 mgm. per litre in the case of ***Anopheles maculatus***, and from 0·87 mgm. in the case of ***A. listoni*** up to super-saturation values of 14·84 mgm. and 12·32 mgm. per litre, respectively. It may be said, however, that waters in which the figure is low are not favoured by anophelines.

In rice fields the presence of ***Anopheles listoni***, the only malaria carrier commonly breeding therein, is shown to be dependent on the presence of a considerable amount of dissolved oxygen, and methods for avoiding this are discussed. The toleration-limits of various species with respect to the above-mentioned factors are discussed at length, and taking ***Anopheles listoni*** as an example the optimum conditions for this species are—*p*H of 6·8-7·0: a conductivity of 300-700 and an oxygen content of 5-7 mgm. per litre. There is shown to be a "feeding-association" of anophelines with certain algæ, on the presence of which that of the mosquitoes probably depends, but these and other points require more space than is available for adequate discussion.

University and Educational Intelligence.

BIRMINGHAM.—Mr. Hugh Donovan, surgical registrar to the Queen's Hospital, has been appointed part-time assistant in the Department of Pathology and Bacteriology.

Gifts recently reported include sums of 50l. each from Sir James Kemnal, the Partington Steel and Iron Co. Ltd., Messrs. Balfour, Beatty and Co., and 50 guineas from Messrs. D. Colville and Sons, Ltd., towards the expenses of the new Fuel Treatment Laboratory in the Coal Mining Department; a model illustrating modern methods of shaft sinking in coal-mines by the François Cementation Co.; and two scholarships of the value of 60l. each, for three years, from Messrs. British Ropes, Ltd., for students in the Oil Engineering and Refining Department.

CAMBRIDGE.—Mr. F. L. Engledow has been appointed a member of the council of the National Institute of Agricultural Botany. Mr. Engledow is a fellow of St John's College; he has since the war been working in the Plant Breeding Institute under Sir R. H. Biffen: his special studies have been in relation to yield in the cereals, effective yield testing and detailed field behaviour of various commercial varieties.

Dr. R. A. Nicholson of Trinity College has been elected to the Sir Thomas Adams's professorship of Arabic, in succession to Prof. E. G. Browne, who died on January 5. Dr. Nicholson was formerly University lecturer in Persian.

LONDON.—The following are among the fellows of University College recently appointed: Mr. J. T. Carter, honorary research assistant in histology, Prof. H. B. Fantham, since 1917 professor of zoology and comparative anatomy, University of Witwatersrand; Dr. Morris Ginsberg, lecturer in the department of philosophy and psychology, and since 1925 University reader in sociology, London School of Economics; Prof. Y. Heyrovský, professor of physical chemistry in the Charles' University of Prague; Mr. L. A. Legros, consulting engineer; Dr. A. G. Levy, physician, City of London Hospital for Diseases of the Chest; Mr. G. Udny Yule, president of the Royal Statistical Society.

The following are among the fellows of King's College recently appointed: Sir James Kingston Fowler, physician to the Middlesex and Brompton Hospitals; Mr. L. B. Atkinson, president in 1920–21 of the Institution of Electrical Engineers and chairman and president-elect of the Electrical Research Association; Prof. W. Wilson, professor of physics at Bedford College.

The following doctorates have been conferred: *D.Sc.* (*Botany*): Mr. M. M. Mehta (Imperial College; Royal College of Science), for a thesis entitled "Studies on Lignification." *D.Sc.* (*Chemistry*): Mr. F. L. Usher, for a thesis entitled "The Nature of the Interfacial Layer between an Aqueous and a Non-Aqueous Phase," and other papers.

MANCHESTER.—Applications are invited for the Lewis Atkinson entrance scholarship in electrical engineering, the annual value of which is 50l. The scholarship is tenable for three years. Forms of nomination and application are obtainable from the Internal Registrar of the University. They must be returned by April 1.

THE Cambridge local lectures available for 1926–27 are listed in a 36-page pamphlet issued by the Board of Extra-mural Studies of the University. The lectures are grouped under the heads: A—natural science, and B—history, geography, political economy, mental science, literature, and art. Four pages are devoted to Group A and twenty-four to Group B. The natural science lecturers are G. P. Bailey (James Stuart lecturer), F. Balfour Browne, H. Yule Oldham, E. A. Parkyn, and Bernard Smith The inclusive fee, covering the lecturer's travelling expenses and, as a rule, everything except strictly local expenses, are 48l.-66l. for a full course of twelve lectures and 33l.-45l for a short course of six. A preliminary programme of the summer meeting, 1926, announces that the main subject of study will be India in ancient, medieval, and modern times, and there will also be lectures and classes in theology, architecture, and geology, and, for foreign students, in English language (including phonetics) and literature The inaugural address will be given on July 29 by the Earl of Ronaldshay.

A PRELIMINARY programme has been issued of the third Congress of the Universities of the Empire, to be held on July 12-16 at Cambridge. The chairman for the morning session of July 13 will be the Earl of Balfour, and the subject of discussion "The State and the University." The afternoon session will be devoted to considering the desirability of establishing in London a school of advanced legal studies (chairman, Viscount Cave). Co-operation in research throughout the Empire, will form the subject of the morning session of July 14, under the chairmanship of the Marquess of Londonderry. The morning session of July 15, under the chairmanship of Sir Matthew Nathan, will be given to a consideration of the mutual recognition of examinations and related topics, while the afternoon session, under the chairmanship of the Duke of Devonshire, will be devoted to the subject of the physical welfare and training of students and the organisation of athletics. At the morning session of July 16, under the chairmanship of the Viscount Cecil of Chelwood, the actual working of the Ph.D. scheme will be discussed, while the afternoon session (chairman, the Viscount Haldane of Cloan) will be occupied with a consideration of the desirability of articulating other pension schemes with the Federated Superannuation System of Great Britain and Ireland.

OFFICIAL statistics of Prussian universities and technical colleges for the summer semester of 1925 show a total of 39,134 matriculated students, including 3234 students from other countries. To these figures may be added the numbers of students in commercial, agricultural, and veterinary colleges, which bring the total up to 42,744, including 3607 from other countries. Of these students from abroad, 1232 were German as regards their mother-tongue, and more than half of them (2110) were enrolled in the University of Berlin (1042) and the Berlin Technische Hochschule (795), Handels-Hochschule (169), Landwirtschaftliche Hochschule (82), and Tierarztliche Hochschule (22). Bulgarian (246), Russian (191), Norwegian (108), and Chinese (101) students were specially numerous in the universities; Bulgarian (158), Russian (140), and Roumanian (134) in the technical colleges. English students in the University of Berlin numbered 10. None of these figures include 'Hörer' or unmatriculated students. The University of Berlin provides through its Deutsche Institut für Ausländer a continuous series of courses in German language, literature, and institutions, each lasting two months. The thirty-eighth of the series (December 1925-January 1926) was attended by 130 students belonging to thirty-two nationalities and including 40 Russians, 17 Japanese and Koreans, 12 Chinese, and 6 Jugo-slavs.

Contemporary Birthdays.

March 13, 1873. Dr. Charles S. Myers, C.B.E., F.R.S.
March 14, 1879. Prof. A. Einstein, For. Mem. R.S.
March 15, 1855. Mr. Charles Vernon Boys, F.R.S.
March 16, 1846. Prof. Gosta Mittag-Leffler, For. Mem. R.S.
March 17, 1863. Sir Herbert Jackson, K.B.E., F.R.S.
March 17, 1847. Sir Alexander B. W. Kennedy, F.R.S.
March 19, 1871. Prof. William Arthur Bone, F.R.S.

Prof. EINSTEIN was born at Ulm (Donau). Nobel laureate in 1921, he was Copley medallist of the Royal Society last year, and recently was awarded the Royal Astronomical Society's gold medal. He is best known, indeed almost popularly known, as the originator of the theory of relativity. In 1905 he showed that the time and space we measure are local in meaning and that we have no means of determining absolute space and time. Then came the identification of mass with energy. In 1915 the earlier theory was extended by a noteworthy generalisation bringing gravity into the scheme. The three crucial astronomical tests of Einstein's general theory of relativity have now all been verified and the theory has even been used to confirm the suspected high density of the white dwarf stars. Einstein has also been concerned in the development of the quantum theory. In 1905 he put forward his law of the photoelectric effect and further contributions on the theory of ionisation and the specific heats of solids culminated in 1917 in another fundamental result—a general equation connecting absorption and emission coefficients.

Mr. C. V. BOYS was born at Wing, Rutland. He was educated at Marlborough and the Royal School of Mines. In 1896 the Royal Society allotted him a Royal medal for the introduction into physical research of refined measurement methods by the use of drawn quartz fibres. Recognition was again accorded by the Society in 1924, when Mr. Boys was awarded the Rumford medal for his invention of the gas calorimeter.

Sir HERBERT JACKSON, Director of Research, British Scientific Instrument Research Association, was formerly Daniell professor of chemistry, University of London, King's College. President of the Rontgen Society, 1901–3, he was president of the Institute of Chemistry, 1918–21. In 1919 he delivered the Trueman Wood lecture at the Royal Society of Arts on "Glass and some of its Problems." Sir Herbert made recently the statement that it is not possible at the present day to obtain anywhere optical glass and optical instruments better than, or in many cases, as good as, those manufactured in Great Britain.

Sir ALEXANDER KENNEDY, consulting engineer, was born at Stepney and educated at the City of London School and the Royal School of Mines. Professor of engineering in University College, London, 1874–89, he there originated the first of the engineering laboratories which now form an essential part of the scientific training in engineering at universities and colleges.

Prof. BONE, chemical and fuel technology engineer, was born at Stockton-on-Tees. Educated at the Friends' School, Ackworth, Stockton Grammar School, and the Leys School, Cambridge he graduated at the Victoria University, Manchester, proceeding afterwards to Heidelberg University, studying there under the late Prof. Victor Meyer. In 1910 the leaders of the coal-gas industry endowed a special chair at the University of Leeds in memory of the late Sir George Livesey, and Prof. Bone was its first occupant. He is the inventor of the 'Bonecourt' system of incandescent surface combustion.

Societies and Academies.

LONDON.

Royal Anthropological Institute (Indian Section), February 23.—**R. E. Enthoven**: Ethnographic research in India. Dealing with the systematic survey of the larger provinces inaugurated by Risley after the census of 1901, the various theories of caste origin were noted, and its present characteristics explained. Stress was laid on the importance of a more thorough record of exogamous caste and tribe divisions, particularly in connexion with the primitive type having many of the aspects of totemism. Further and more extensive work of the nature of recent anthropometrical observations in India is necessary. For the immediate future, the compilation of an all-India record of tribes and castes, and the limitation of the scope of inquiry in regard to both social structure and primitive custom to the already existing questionnaires drawn up by experts are desirable.

Optical Society, February 25.—**O. Aves**: Notes on the significance and detection of low errors of refraction. Examination of a great number of records of tests on the eye for the purpose of prescribing spectacles reveals a large proportion of low errors of refraction. Certain modifications of the usual technique should be incorporated when testing such cases. The usual objective methods of sight examination prior to a subjective test are practically useless in the estimation of errors less than one dioptre; they produce distinct after-images on and around the macular area, which perceptibly interfere with vision. In the subjective test the lenses should be added binocularly, before testing the eyes separately. The blocking of one eye tends to induce strain. Change of lenses during a test should be made smoothly without allowing the eyes to be uncovered by a lens or to be covered by two lenses. Other points in the testing of small errors are the strength of the spherical and cylindrical lens elements, the direction of the axis of the cylinder, refinement of the test for muscular correction, and the possibility of the presence of irregular astigmatism.—**W. H. A. Fincham**: Vertex power and its measurement. The demand for increased accuracy in the determination of refractive errors has emphasised the need for accurate specification and measurement of the powers of correcting lenses. The effect of an ophthalmic lens may be expressed in a number of different ways. The following quantities are used: (1) Equivalent or true power; (2) vertex power or vertex refraction, *i.e.* the power at the vertex nearer the eye; (3) neutralising power, usually the front vertex power; (4) thin lens power, *i.e.* the sum of the powers of the two surfaces, thickness being neglected. In the case of ophthalmic lenses, vertex power is the important quantity, as it gives the effective value of the lens at some definite and easily determined point on the lens, and consequently lenses of any form having the same vertex power are interchangeable if the vertex of each lens occupies the same position with respect to the eye.

CAMBRIDGE.

Philosophical Society, February 1.—**F. G. Mann** and **Sir W. J. Pope**: Metallic complexes with aliphatic poly-amines. The preparation and configuration of complex compounds of platinum, palladium, rhodium, cobalt and nickel with $\alpha\beta\gamma$ triaminopropane, $\beta\beta'\beta''$ triaminotriethylamine, and $\gamma\gamma'\gamma''$ triaminotripropylamine is described.—**R. T. M. Haines** and **Sir W. J. Pope**: Isoquinoline and the isoquinoline reds. By fractional precipitation of coal-tar quinoline, the amount of isoquinoline present was shown to be nearly 5·5 per cent., or six times as much as was supposed. The reaction leading to the production of isoquinoline red and its homologues is a delicate test for the presence of a reactive methyl-group such as exists in quinaldine. Anhydrous ferric chloride and stannic chloride are as efficient condensing agents as aluminium chloride.—F. H. **Constable**: The behaviour of the centres of activity of saturated surfaces during the initial stages of unimolecular reaction. While decrease in pressure of the reactant has little effect on the velocity of reaction at saturated surfaces, chemically inert diluents cause a marked decrease. These results confirm that the molecules do not react at the instant they bombard the surface, but during the period they remain absorbed. An extension of the Langmuir-Frenkel theory to the dynamics of adsorption on the centres of activity accounts quantitatively for the facts.—A. J. **Berry**: Direct titration of thallous salts by potassium iodate. Thallous salts are capable of quantitative oxidation to the thallic condition by potassium iodate in the presence of a high concentration of hydrochloric acid. Iodine liberated during the reaction is oxidised to iodine monochloride, hydrolysis of the latter being suppressed by the high concentration of hydrochloric acid present.—R. G. W. **Norrish**: influence of surfaces on the combination of ethylene with the halogens. The suspension of reactivity resulting from the drastic drying of potentially reactant systems is rather to be ascribed to a drying of the apparatus, than to any ultra-dryness of the reactants. For example, if the bimolecular velocity coefficient or the surface reaction between ethylene and chlorine in glass vessels be represented by unity, then in similar paraffin wax vessels it falls to 0·0008, even if the gases are moist. When the glass vessels are baked out under a high vacuum, the velocity coefficient falls to 0·12 in spite of the fact that a small portion of the vessel remains of necessity undried. Since the whole of the reaction occurs via the adsorbed surface film, these results indicate that only sufficient water is necessary for full reaction as will saturate the surface with (probably) a unimolecular layer; thus though present only in very small quantities, water may still enter stochiometrically into the reaction equation. —W. A. **Waters**: The chlorination and bromination of 4-aminodiphenyl.—**Miss M. Wright**: Oxidation at charcoal surfaces. Sugar charcoal brings about the oxidation of oxalic acid in dilute solutions, and is itself slowly oxidised. Fractional poisoning experiments show that the two processes are independent, and occur on different parts of the charcoal surface. On blood charcoal there are two catalytically active areas, one small, highly active area containing iron, which is preferentially poisoned by potassium cyanide; and another larger, less active area, similar to that on sugar charcoal. Iron-containing charcoals have been prepared free from nitrogen; when these are reduced in hydrogen, they contain two catalytic surfaces, similar to those of blood charcoal. Nitrogenous charcoals are very active, owing to their large specific surface.

MANCHESTER.

Literary and Philosophical Society, February 9.—R. A. **Wardle**: Rain cotton in the Sudan. The southern Sudan is not an ideal area for cotton grown under rainfall conditions owing to the shortness of the rainy season and to the uncertain distribution of the annual rainfall. Indigenous short staple cottons have been grown, however, for at least eighty years, and experiments have shown that American long staple varieties can be grown successfully and will produce cotton sufficient in quality and quantity to warrant the establishment of cotton cultivation in the Central and Southern Provinces, thus enabling these areas to obtain a surplus of income over expenditure available for developmental schemes. The Government policy is to encourage the cultivation of American long staple varieties by issuing free seed and by providing marketing and ginning facilities. The ultimate limit of acreage under rain cotton will depend largely upon the extent to which road and rail communication between districts and ginneries can be developed.—W. E. **Alkins**: The influence of the metallic contact between the component wires upon the electrical resistance of a stranded conductor. The resistance of a stranded conductor composed of bare wires is usually calculated upon the assumption that the component wires behave in respect of the transport of electrons as though they were insulated from each other. This assumption has been tested experimentally in the case of a conductor consisting of seven copper wires. It was found that the resistance of the stranded conductor was equal, within the limits of experimental error, to that calculated by means of the Reciprocal Law from the resistances of the component wires, and that the metallic contact between the individual wires was therefore without appreciable influence.

PARIS.

Academy of Sciences, February 8.—Emile **Haug**: Fossils of the middle Lias collected by the Charcot expedition at Cape Stewart (Jameson's Land, East Greenland). The fossils found are characteristic of the middle Lias. This view is not in agreement with the results of B. Lundgren (Danish expedition 1891–92).—Georges **Claude**: The explosion at Boulogne-sur-Seine. An account of a fatal explosion of a liquid air plant, and a discussion of the possible causes of the accident.—Ch. **Depéret**: Excavations for prehistoric remains in the layer in which the fossil men of Denise (near Puy-en-Velay) were found.—C. **Sauvageau**: A new type of alternation of generations in the brown algæ.—André **Bloch**: Some theorems on the integral and meromorph functions of a variable.—Kyrille **Popoff**: The gaps which may be presented by a Taylor's series representing a regular analytical function at infinity, and only admitting one singular point which is an essential singular point.—Eugène **Barré**: The theory of [military] mine explosions.—Léon **Brillouin**: Rotation spectra, in the new quantum mechanics, with calculation of the matrices.—André **Pignot**: The adiabatic ignition of hydrocarbon mixtures. The method adopted was the determination of the initial temperature necessary to obtain ignition with a fixed volume compression. The hydrocarbons chosen were those present in ordinary petrol. Experiments were also made with alcohol.—René **Lucas**: The rotatory power of camphor. The hypothesis that camphor can exist in two molecular forms possessing different rotatory powers and dispersions, and that the proportion of these two forms varies from one solvent to another, is in agreement with the experimental results given in this and in an earlier communication.—Mlles. Ellen **Gleditsch** and C. **Chamié**: Contribution to the study of 2-mesothorium and of actinium: These experiments confirm and complete the work of Yovanovitch: the chemical reactions of mesothorium-2 resemble those of the cerium earths, more especially lanthanum.—Albert **Portevin** and François **Le Chatelier**: Some physical properties of the ultra light magnesium alloys. Determinations of specific volume, electrical resistance and coefficient of expansion of magnesium alloys. The most interesting types from the point of view of practical utility are the binary alloys with nickel or copper, and the ternary alloys magnesium-aluminium-nickel and magnesium-aluminium-copper —A. **Lassieur** . The magnesia carried down by aluminium hydroxide If to a solution containing aluminium and magnesium only just sufficient ammonia is added to precipitate the alumina (pH = 7) no magnesia is precipitated. With increasing quantities of ammonia, there is increased precipitation of the magnesia —L. **Blanc** and G. **Chaudron** : Study of the transformation and oxidation of chromium sesquioxide —André **Kling** and Daniel **Florentin** · The hydrogenation of organic substances realised at a high temperature and under high pressure. The temperatures at which hydrogenation commences were determined for various organic compounds, and these coincided with the temperatures at which decomposition commenced. It is concluded that in hydrogenation at high temperatures and pressures it is molecular hydrogen which acts on nascent organic molecules —**Tiffeneau** and Mlle. J. **Levy** . The isomerisation of the ethylene oxides and comparison of the affinity capacities of some cyclic and acyclic radicals —Marcel **Godchot** and Pierre **Bedos** . The stereoisomeric *o*-methyl-cyclopentanols —Louis **Barrabé** The mode of formation and the age of the eruptive rocks of the middle region of the Sakalave country (west of Madagascar).—P **Fallot** and R **Bataller** : The direction and age of the folds in the mountains of Bas-Aragon and Maestrazgo (Spain) —L. **Lavauden** and M **Solignac** . Some geological results of the Trans-saharan expedition of Colonel Courtot (1925).—A. **Demay** · The Hercynian tectonic of Maures —Ch. **Lormand** : Chemical analysis of the Capvern (Hautes-Pyrénées) mineral water —J **Thoulet** : Submarine volcanism at great depths . A **Renier** · The general morphology of Ulodendron —Ch. **Brioux** and J. **Pien** . The comparative fertilising action of the different forms of nitrogen existing in the new ureic nitrogenous manures derived from cyanamide Results with experimental cultures containing ammonium sulphate, guanylurea sulphate, or dicyandiamide, with special reference to the effect on nitrification —**Doyon** and I. **Vial** : The isolation of an extremely active anti-coagulating substance free from phosphorus by the prolonged autolysis of organs and acid alcohol.—Emile F. **Terroine** and Mlle Anne Marie **Mendler** . The influence of the nature of the ternary foods on the amount of nitrogen retention in the course of growth.—J. **Cristol**, L **Hedon**, and A **Puech** . The passage of the digestive polypeptides into the portal circulation and their arrest in the liver. Details of experiments proving that polypeptides pass into the portal vein in the course of digestion, and are arrested by the liver, since they are not found in the arterial blood —A. **Policard** and M. **Boucharlat** The mechanism of the characters of the plasma of sarcomatous animals making it suitable for a medium for the culture of tissues

CALCUTTA.

Asiatic Society of Bengal, January 4 —P. C. **Mahalanobis** : Analysis of race-mixture in Bengal. Measurements of 200 individuals of Anglo-Indians (new style) in Calcutta are compared with 30 typical castes of North India, representing about 6 geographical divisions and 4 or 5 cultural strata. Intermingling has not been chaotic ; it presents a gradual and well-ordered character in which cultural affinity and cultural selection have played a very important part.—MM. Haraprasad **Shastri** : Bhadra Yāna There has been a gradual increase of number of yānas known Yāna = a school of thought, modern Indian "panth" The yāna was founded by Bhadrapāda. The central teaching is the negation of the citta —Johan van **Manen** : The Pali Text Society's Pali-English Dictionary.

ROME.

Royal Academy of the Lincei, December 20 —Francesco **Severi** : Constant level curves of Picard's integrals —O. M. **Corbino** · Thermo-electric power and Hall's effect.—Michele **Cantone** . New method of studying experimental results It is often useful, in addition to the curve showing the variation of any phenomenon with a particular property, to trace the curve showing the relation between the corresponding increments.—Achille **Russo** : The first accessory conjugation between impure gametes in *Cryptochilum echini* Maupas.—Beniamino **Segre** : A property of symmetrical determinants of the sixth order.—Carlo **Severini** : Convergence of the series of orthogonal functions.—Giovanni **Sansone** : Indeterminate equations of unity of negative type in real quadratic bodies. The case $D = 2p$, with p prime.—G. **Wataghin** : Dependence of the velocity of light on the movement of the source.—E. **Billows** : Crystals of sulphur accompanying the anglesite and galena of Monteponi. —Helios **Scaetta** . Partial hermaphroditism and parthenocarpia in *Phœnix dactylifera* L.

VIENNA.

Academy of Sciences, January 14.—O. **Wettstein** : A new lizard of the genus Enyalius from Ecuador. Specimens are in the Vienna Natural History Museum. —A. **Duschek** : The relative theory of surfaces.—F. **Holzl** Organic acids and bases in non-aqueous solutions —E **Heinricher** . Is the formation of haustoria in Santalaceæ produced by chemical stimulation or by contact ?—Fr. **Hlucka** : Comparison between the dispersion formulæ of the atomic theory and of the continuity theory —A. **Köhler** · Report on the progress of the petrographic-geological researches in the south-western Waldviertel (Lower Austria) —H **Handel-Mazzetti** : Plantæ novæ Sinenses (xxxix.)

WASHINGTON, D C.

National Academy of Science (Proc Vol 12, No 1, January).—Ernest W **Brown** . The effect of varying mass on a binary system . a correction [to a paper in the May issue of the *Proceedings*].—Charles E. **Allen** : The direct results of Mendelian segregation If it is possible to recognise the four spores formed by division of a single mother cell, some indication of the effects of chromosome segregation can be expected in the haploid plants developing from the spores Generally each tetrad of spores contains two types of spore only as regards the two characters examined in *Sphærocarpos Donnellii* , tetrads with the possible four different spores formed a small minority —John **Belling** and A F. **Blakeslee** On the attachment of non-homologous chromosomes at the reduction division in certain 25-chromosome daturas —M **Demerec** . Reddish—a frequently 'mutating' character in *Drosophila virilis*. 'Reddish' is a body colour characteristic which seems to be an allelomorph of yellow and mutating frequently to wild type —W. E **Castle** . The explanation of hybrid vigour Recent evidence supports the heterosis (or heterozygosis) theory that the vigour of hybrids arises from the fact that they are heterozygous for all genetic factors in which the parents differed This leads to an acceleration of all metabolic processes in hybrids.—Gregory Paul **Baxter** and Howard Warner **Starkweather** . The density and atomic weight of helium (ii.). 2-litre globes were used instead of 1-litre (NATURE, July 11, 1925, p. 68). Original values obtained when corrected give the density as 0·17846. The average density at a pressure of half an atmosphere is exactly one-half that at a pressure of one atmosphere. The density of oxygen being 1·42898, the atomic weight is very close to 4·000.—**Gilbert N. Lewis**: The nature of light (see NATURE, February 13, p. 236).—**Ernest Orlando Lawrence**. The rôle of the Faraday cylinder in the measurement of electron currents. For electrons under accelerating voltages up to about 24 volts there is a regular increase of electron current to the Faraday cylinder, with increase of length of the latter. With accelerating voltages of 20 to 100 volts, secondary electrons generated by impact in the cylinder lead to large variations in the electron current measured.—**Linus Pauling**: The quantum theory of the dielectric constant of hydrogen chloride and similar gases. The electric moment of the molecule in hydrogen chloride is that of a dipole with proton and electron 0·0694 Å.U. apart; for hydrogen bromide the distance is 0·0528 Å.U.—**L. B. Loeb**: (1) The mobility of gaseous ions in HCl gas and HCl air mixtures. In pure dry hydrogen chloride gas, the average mobilities of the positive and negative ions at 20° C. and 760 mm. mercury pressure are 0·65 cm./sec. per volt/cm. and 0·56 cm./sec. per volt/cm. In mixtures with air there is evidence of the formation of labile clusters formed by increased concentration of molecules of one type in the neighbourhood of the ion. (2) The mobility of gas ions in HCl mixtures and the nature of the ion. Assuming an inverse fifth power law, it is calculated that the molecules of higher dielectric constant in a mixture are present in far greater numbers in the immediate neighbourhood of the ion than in the rest of the gas. This would account for the labile clusters evidence for which was found above. The nucleus plays an exceedingly minor rôle in determining values of ionic mobility.—**R. A. Millikan**: High-frequency rays of cosmic origin (see NATURE, December 5, 1925, p. 823).—**J. R. Roebuck**: The Joule-Thomson effect in air. The porous plug used consisted of a porcelain tube with a rounded end, and great precautions were taken to ensure that the inlet pressure was maintained constant. Inlet pressure of 30 to 220 atmospheres and temperatures of 25° to 300° C. were used. The Joule-Thomson effect falls steadily with rising temperature and pressure, passes through zero, and becomes negative. The coefficient of expansion at constant pressure increases with both temperature and pressure but at a decreasing rate. The temperature of the ice-point works out as 273°·15 K.—**Joseph Miller Thomas**: On normal co-ordinates in the geometry of paths.—**E. B. Stouffer**: A simple derivation of Kronecker's relation among the minors of a symmetric determinant.

Official Publications Received.

The Vredefort Mountain Land in the Southern Transvaal and the Northern Orange Free State. Shaler Memorial Series. By Dr. A. L. Hall and Prof. Dr. G. A. F. Molengraaff. (Verhandelingen der Koninklijke Akademie van Wetenschappen te Amsterdam (Tweede Sectie), Deel 24, No. 3.) Pp. xiv+183+59 plates. (Amsterdam: Koninklijke Akademie van Wetenschappen.)

Aeronautical Research Committee Reports and Memoranda, No. 961 (Ae. 194): The Design of the Pitot-Static Tubes. By E. Ower and F. C. Johnson. (C.1. Accessories Instruments, 88 and a.—T. 2108 and a.) Pp. 12+11 plates. (London: H.M. Stationery Office.) 9d. net.

Ministry of Finance, Egypt: Coastguards and Fisheries Service. Report on the Fisheries of Egypt for the Year 1924. By Kaimakam G. Jenkins Bey. Pp. vii+50+4 charts. (Cairo: Government Publications Office.) 5 P.T.

Scottish Marine Biological Station. Annual Report 1924–25. Pp. 23. (Glasgow.)

United States Department of Agriculture. Department Bulletin No. 1357: The Strawberry Rootworm, a new Pest on Greenhouse Roses. By C. A. Weigel. Pp. 48. (Washington, D.C.: Government Printing Office.) 10 cents.

Publications of the Kapteyn Astronomical Laboratory at Groningen. No. 38: On the Frequency of the Absolute Magnitudes of the Stars. By Prof. Dr. P. J. Van Rhijn. Pp. vi+77+2 plates. (Groningen: Hoitsema Bros.)

Transactions of the Royal Society of Edinburgh. Vol. 54, Part 2, No. 6: A Contribution to the Life-History of Bowenia. By Prof. A. Anstruther Lawson. Pp. 357-394+8 plates. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 7s. 6d.

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 8, No. 7: Deterioration of Sugarcane during its Storage by Windrowing. By Phani Bhusan Sanyal. Pp. 101-126. (Calcutta: Government of India Central Publication Branch.) 6 annas; 8d.

Board of Education. Educational Pamphlets, No. 46: Rural Education. Adaptation of Instruction to the Needs of Rural Areas; a Survey of the Present Position. Pp. 59. (London: H.M. Stationery Office.) 9d. net.

Conseil Permanent International pour l'Exploration de la Mer. Publications de Circonstance, No. 90: Quelques observations sur l'emploi de l'eau normale en océanographie. Par Prof. J. Giral. Pp. 22. (Copenhague: Andr. Fred. Høst et fils.)

United States Department of Agriculture Library. Bibliographical Contributions, No. 11: List of Manuscript Bibliographies and Indexes in the U.S. Department of Agriculture, including Serial Mimeographed Lists of Current Literature. Compiled by H. Lucy Ogden and Emma B. Hawks. Pp. 83. (Washington, D.C.)

Memoirs of the Geological Survey of India. Vol. 52, Part 1: On the Geological Structure of the Karanpura Coalfields, Bihar and Orissa. By Dr. Albert Jowett. Pp. v+144+14 plates. (Calcutta: Government of India Central Publication Branch.) 7.8 rupees; 12s.

Smithsonian Miscellaneous Collections. Vol. 77, No. 10: An Archeological Collection from Young's Canyon, near Flagstaff, Arizona. By J. Walter Fewkes. (Publication 2838.) Pp. 15+9 plates. (Washington, D.C.: Smithsonian Institution.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 67: Seasonal Variation in Pink Boll-Worm Attack on Cotton in Egypt in the Years 1916–1924. By C. B. Williams. Pp. 12+8 plates. (Cairo: Government Publications Office.) 5 P.T.

British Museum (Natural History). Picture Postcards. Set D7: Ornamental Stones, Series No. 1. 5 cards in colour. 1s. Set D8: Ornamental Stones, Series No. 2. 5 cards in colour. 1s. Set E39. Exotic Butterflies, Series No. 6. 5 cards in colour. 1s. Set E40. Exotic Moths, Series No. 9. 5 cards in colour. 1s. Set E41: Exotic Beetles, Series No. 4. 5 cards in colour. 1s. Set E42: Hymenoptera, Series No. 1. 5 cards in colour. 1s. (London: British Museum (Natural History).)

The Physical Society of London. Proceedings, Vol. 38, Part 2, February 15. Pp. 93-163. (London: Fleetway Press, Ltd.) 6s. net.

Academia Română. Memoriile Secțiunii Științifice, Seria 3, Tomul 3, Mem. 7: Über Chinas Pyraliden, Tortriciden, Tineiden nebst kurze Betrachtungen, zu denen das Studium dieser Fauna Veranlassung gibt (eine Biogeographische Skizze). Von Aristide Caradja. Pp. 150+2 Tafeln. (Bucareşti: Cultura Naţională.)

Department of Zoology, University College of Wales, Aberystwyth. New Series, Vol. 1: Report on Marine and Fresh Water Investigations. Edited by R. Douglas Laurie. Pp. iv+48. (Aberystwyth.) 5s.

Proceedings of the Royal Society of Victoria. Vol. 37 (New Series), Part 2. Pp. 151-276+plates 17-23. (Melbourne.)

U.S. Department of the Interior. Annual Report of the Commissioner of Education to the Secretary of the Interior for the Fiscal Year ended June 30, 1925. Pp. iii+36. (Washington, D.C.: Government Printing Office.) 10 cents.

Memoirs of the University of California. Vol. 7: The Motion and the Distribution of the Stars; Lectures delivered at the University of California, 1924. By Prof. Carl Wilhelm Charlier. Pp. vii+127. (Berkeley, Calif.)

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 29: Land-Grant College Education, 1910–1920. Edited by Walton C. John. Part 5: Home Economics. Pp. iv+91+8 plates. 15 cents. Bulletin, 1925, No. 30: The Progress of Dental Education. By Prof. Frederick C. White. Pp. 27. 5 cents. (Washington, D.C.: Government Printing Office.)

Diary of Societies.

SATURDAY, MARCH 13.

ROYAL SANITARY INSTITUTE (at Town Hall, Hastings), at 10.30 A.M.—Dr. G. R. Bruce, Miss Hester Viney, Dr. J. Fenton, and others: Discussion on Mothercraft and Fathercraft.—J. Parkin, H. T. Taylor, and others: Discussion on The Effect of the Public Health Act of 1925 on the Work of Municipal Engineers and Sanitary Inspectors.

BIOCHEMICAL SOCIETY (at University College), at 2.15.—C. R. Harington: Chemistry of Thyroxin—(a) Method of Isolation from the Thyroid Gland; (b) Constitution and Synthesis of Iodine-free Thyroxin.—H. J. Channon: Some Experiments on the Biological Significance of Squalene (Spinacene).—H. J. Channon and G. F. Marrian: An Unidentified, Unsaturated Hydrocarbon occurring in Mammalian Liver.—Prof. I. M. Heilbron: The Chemical Nature of Squalene (Spinacene).—F. H. Carr and E. A. Price: Colour Reactions attributed to Vitamin A.—H. Jephcott and A. L. Bacharach: Studies in the Vitamins of Cod Liver Oil. Part I.—Prof. H. S. Raper: The Production of 3.4 Dihydroxy-phenylalanine from Tyrosine by the Action of Tyrosinase.—R. K. Cannan, Dr. P. Haas, and T. G. Hill: Oxidation-Reduction Potential of Hermidin (Chromogen of *Mercurialis perennis*).—Dr. C. Dorée and E. C. Barton-Wright: A Note on the Stone-Cells of the Pear.—Margaret H. O'Dwyer: On the Nature of the Hemicelluloses.—H. D. Carey: The Relation between Hydrogen Sulphide, Hyposulphites, and Thiosulphates; by a New Method of Structural Formulæ.—E. Ponder: The Shape of the Erythrocyte and its Respiratory Function.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Rare Gases of the Atmosphere and their Importance in Atomic Theory (2).

British Psychological Society (at University College), at 8.—Dr. Eliza A. Collie: The Upper Limits of the Growth of Intelligence.—S. J. F. Philpott: Some Further Notes on Work Curves.

Institute of Transport (North-Eastern Local Section) (at Town Hall, Newcastle-upon-Tyne), at 3.—Prof. J. H. Jones: State Ownership of Waterways.

Scottish Junior Gas Association (at Royal Technical College, Glasgow), at 7.—S. H. Hunter: Scientific Service.

MONDAY, March 15.

Institution of Post Office Electrical Engineers (at Royal Technical College, Glasgow), at 2.30.—Capt. Hill: The Engineering Aspect of Telephone Exchange Accommodation.

Cambridge Philosophical Society (Special Meeting) (in Cavendish Laboratory), at 4.30.—Prof. A. Sommerfeld: Some Controversial Points in the Theory of Spectra (Lecture, in English).

Victoria Institute (at Central Buildings), at 4.30.—Rev. Canon V. F. Storr: Revelation.

Royal Geographical Society (at Lowther Lodge), at 5.

Royal College of Surgeons of England, at 5.—Mr. Shattock: Demonstration of Specimens of Some Bone Tumours.

Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—J. E. Allan, A. G. Barnard, and others: Discussion on Electricity on Board Ships.

Institution of Electrical Engineers (North-Eastern Centre) (at Sopwith's Lounge, Newcastle-on-Tyne), at 7.—Informal Discussion on Power Station Economics.

Institution of Electrical Engineers (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.15.—R. B. Matthews: Electro-Farming; or the Application of Electricity to Agriculture.

Institution of Automobile Engineers (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—Dr. W. R. Ormandy: The Production of Oil.

Royal Institute of British Architects, at 8.

Royal Society of Arts, at 8.—W. F. Higgins: Thermometry (Cantor Lectures) (1).

Medical Society of London, at 9.—Dr. E. F. Buzzard: The Principles of Treatment in relation to Diseases of the Nervous System (Lettsomian Lectures) (3).

Chemical Industry Club.

TUESDAY, March 16.

Royal Irish Academy (at Dublin), at 4.15.

Royal College of Physicians of London, at 5.—Dr. B. Hart: The Development of Psycho-pathology and its Place in Medicine (Goulstonian Lectures) (2).

Royal Institution of Great Britain, at 5.15.—Prof. C. H. Desch: The Growth of Crystals (1).

Royal Statistical Society (at Royal Society of Arts), at 5.15.—Major P. Granville Edge: The Growth of Mortality due to Motor Vehicles in England and Wales, 1904–23.

Mineralogical Society (at Geological Society), at 5.30.—A. H. Hallimond: Molecular Volume Relations in the Mica Group.—E. D. Mountain: (*a*) Smithsonite from the Rhodesia Broken Hill Mines, (*b*) The Identity of the Cobija and Lampa Meteoric Stones.

Institution of Electrical Engineers (North-Western Centre) (at Engineers' Club, 17 Albert Square, Manchester), at 7.—L. C. Grant: Developments in High Power Fuses.

Royal Photographic Society (Scientific and Technical Group) (Annual Meeting), at 7.—W. B. Ferguson: Standardisation of the Measurements of Photographic Density.—T. Thorne Baker and W. A. Balmain: The Effect of Colour-Sensitiveness on the Gradation of a Photographic Plate.

Society of Chemical Industry (Birmingham and Midland Section) (Annual Meeting) (at Birmingham University), at 7.15.—Prof. A. R. Ling: Communications from the Department of the Bio-chemistry of Fermentation.

Institute of Metals (Sheffield Local Section) (at Sheffield University), at 7.30.—G. B. Brook: Aluminium: Where and How it is made.

North-East Coast Institution of Engineers and Shipbuilders (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—A. E. Mitchell: Heavy Timber Construction in Harbour and Dock Works.

Royal Anthropological Institute, at 8.15.—Dr. G. Landtman: Some Agricultural Rites of the Kiwai Papuans.

British Institute of Philosophical Studies (at Royal Society of Arts), at 8.15.—Prof. S. Alexander: Artistic and Cosmic Creation (Lecture).

Royal Society of Medicine (Pathology Section) (Annual Meeting), at 8.30.

WEDNESDAY, March 17.

Institution of Civil Engineers (Students' Meeting), at 6.—J. G. Kimber: The Production of Gaseous Fuel.

Institution of Electrical Engineers (Sheffield Sub-Centre) (at Sheffield University), at 7.30.—S. Evershed: Permanent Magnets in Theory and Practice (Second Paper).

Royal Meteorological Society, at 7.30.—Prof. S. Chapman: Some Recent Advances in Atmospheric Physics (G. J. Symons Memorial Lecture).

Royal Society of Arts, at 8.—Lieut.-Col. J. H. Borastan: Co-Partnership.

C.B.C. Society for Constructive Birth Control and Racial Progress (at Essex Hall, Strand), at 8.—E. J. Ledbetter: Social Inadequacy and the Size of the Family (Lecture).

Institution of Structural Engineers (jointly with the British Section of the Society of Civil Engineers of France), at 8.—A. Knappen: Notes on the Restoration of the Palace of Versailles and the Trianon.

Institute of Chemistry (London Section).

Society of Glass Technology (at Stourbridge).

THURSDAY, March 18.

Royal Society, at 4.30.—Prof. S. Chapman, J. Topping, and J. Morrall: On the Electrostatic Potential Energy, and the Rhombohedral Angle, of Carbonate and Nitrate Crystals of the Calcite Type.—Prof. A. O. Rankine: The Effect of Temperature on the Viscosity of Air.—G. I. Finch and L. G. Cowen: Gaseous Combustion in Electric Discharges. Part I.—C. N. Hinshelwood and W. K. Hutchison: A Homogeneous Unimolecular Reaction—the Thermal Decomposition of Acetone in the Gaseous State.—*To be read in title only*:—Prof. H. Lamb: On Wave Resistance.—C. B. Eddy and A. H. Turner: The L Emission Series of Mercury.—G. R. Goldsbrough: The Properties of Torsional Vibrations.—E. T. Hanson: The Theory of Ship Waves.

Royal College of Physicians of London, at 5.—Dr. B. Hart: The Development of Psycho-pathology and its Place in Medicine (Goulstonian Lectures) (3).

Linnean Society, at 5.—J. L. Sager: Phyllody of the Corolla in *Primula vulgaris* Huds.—Dr. R. T. Gunther: An Early MS. of Apuleius Barbarus c. 1100 A.D. in Facsimile.—G. P. Farran: The Copepoda Collected by H.M.S. *Research* in 1900.—Dr. Helena Bandulska: The Cuticles of Some Fossil and Recent Lauraceae.

Royal Institution of Great Britain, at 5.15.—Prof. J. Holland Rose: The Indecisiveness of Modern Warfare (1).

Institution of Mining and Metallurgy (at Geological Society), at 5.30.

Child-Study Society (at Royal Sanitary Institute), at 6.—Miss C. von Wyss: Spiders as a Nature Study Topic.

Institution of Electrical Engineers, at 6.—L. C. Grant: Developments in High-Power Fusible Cut-Outs.

Society of Chemical Industry (Birmingham and Midland Section) (at Chamber of Commerce, Birmingham), at 7.15.—Prof. W. A. Bone: Some Recent Advances in our Knowledge of Gaseous Combustion.

Institute of Metals (London Local Section) (at Institute of Marine Engineers), at 7.30.—Dr. C. J. Smithells: The Preparation and Structure of Wires of Pure Tungsten.

Chemical Society, at 8.—R. J. W. Le Fèvre and E. E. Turner: Orientation Effects in the Diphenyl Series. Part II. The Constitution of Bandrowski's Dinitrobenzidine.—H. R. Ing and R. Robinson: The Orientating Effect of Free and Bound Ionic Charges on Attached Simple and Conjugated Unsaturated Systems. Part I. The Nitration of some Benzylamine Derivatives.—R. S. Cahn and R. Robinson: The Morphine Group. Part IV. A New Oxidation Product of Codeine.

Royal Society of Tropical Medicine and Hygiene (Laboratory Meeting) (at Royal Army Medical College, Grosvenor Road, S.W.), at 8.15.—Demonstrations by: Prof. Warrington Yorke (on behalf of Prof. Blacklock), Dr. P. A. Buxton, Col. Clayton Lane, Col. W. P. MacArthur, Dr. A. C. Stevenson, Dr. J. G. Thomson and Dr. A. Robertson, Dr. C. M. Wenyon and Dr. H. H. Scott.

FRIDAY, March 19.

Institution of Municipal and County Engineers (North-Western District Meeting) (at Victoria Hotel, Deansgate, Manchester), at 2.30.—Sir Lewis Beard: New Legislation affecting Local Authorities, including the Public Health Act, 1925, and the Roads Improvement Act, 1925.

Institute of Hygiene, at 3.30.—Dr. R. S. Stevenson: Affections of the Ear, Nose, and Throat and their Prevention.

Royal Society of Arts (Indian Section), at 4.30.—Lady Chatterjee: Women and Children in Indian Industries.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Demonstration of Specimens of Hydrocephaly and Encephalocele.

Society of Chemical Industry (Liverpool Section, jointly with Manchester Section) (at Liverpool University), at 6.—Prof. T. P. Hilditch: Structural Chemistry of the Higher Fatty Acids.

Institution of Mechanical Engineers, at 6.—A. E. L. Chorlton: The High Efficiency Oil-Engine.

Institution of Structural Engineers (Yorkshire Branch) (at Great Northern Hotel, Leeds), at 6.30.—C. A. Harding: Some Preliminary Factors affecting the Design of Industrial Buildings.

Royal Photographic Society, at 7.—H. Bairstow: Photography as a Medium of Art Expression.

Photomicrographic Society (at 4 Fetter Lane), at 7.—Members' Evening.

Society of Chemical Industry (South Wales Section) (Annual General Meeting) (at Swansea Technical College), at 7.30.—C. A. Seyler: Chairman's Address.

Junior Institution of Engineers, at 7.30.—G. H. Willett: Pipe Work: Its Manufacture and Layout.

Royal Institution of Great Britain, at 9.—J. Tweed: Chips from a Sculptor's Note-Book.

SATURDAY, March 20.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: The Rare Gases of the Atmosphere and their Importance in Atomic Theory (3).

Physiological Society (at University College).

British Mycological Society (at Lister Institute).

PUBLIC LECTURES.

SATURDAY, March 13.

Horniman Museum (Forest Hill), at 3.30.—Dr. H. G. Cannon: How Animals Feed and what they Eat.

MONDAY, March 15.

St. Thomas's Hospital, at 5.—Prof. R. H. A. Plimmer: The Importance of Vitamins. (Succeeding Lecture on March 16.)

SATURDAY, March 20.

Horniman Museum (Forest Hill), at 3.30.—C. Daryll Forde: Agriculture and the Origin of Civilisation.

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The Coal-mining Industry in Great Britain.

THIS eagerly expected Report of the Coal Commission, which was issued on March 11, constitutes a document of the highest interest and importance (H.M.S.O.; 1*s.* net). The Commissioners evidently have been impressed by the gravity of the situation and the magnitude of the task entrusted to them, and have spared no pains in making a complete investigation of the questions involved.

It may be said at once that, as might be expected from the exceptional qualifications of the Commissioners, the report is an eminently sound and sane one, and the best evidence of this lies in the fact that it has impartially dissatisfied all parties to the dispute. It is too often forgotten that there are at least three parties concerned, namely, the miners, the mine-owners, and the general public: the first two are articulate, not to say vociferous; the third is so inarticulate that its interest, vital though it is, is too frequently overlooked. It is sincerely to be wished, though the hope is scarcely likely to be realised, that the public would bestir itself sufficiently to read this report and would for once find a means of expressing its views.

It is obviously impossible to discuss in detail so voluminous a report; only a few of the main recommendations can here be considered. Perhaps the recommendation which will impress most people is that coal royalties shall be acquired by the State by purchase from their present owners. There is no fault at all to find with the principle of State ownership of minerals; as a matter of fact the greater portion of the minerals in the world are owned by the States within the territories of which they lie and are granted to mine-workers in the form of concessions. The most striking exceptions to this general method are to be found in Great Britain and the United States, where the minerals are the property of individuals or have been acquired by them. Incidentally it may be noted that these are the two countries in which mining has made the most progress and in which the wages of miners are the highest; this fact may be only a coincidence, or it may possibly be more deeply rooted than we are able to see at present in the condition of private ownership of the minerals.

The Commissioners amply justify the position that royalties are a perfectly legal form of ownership, and that if the State desires to acquire them it will have to pay for them. Their reasons are set out in the historical account which they give of royalties, but they by no means present the case in its entirety, because it is in fact much stronger than the report would lead the reader to believe; the opinion of the Commissioners that the State should now repair the error which it made when it parted with these royalties would lead the reader to infer that the State had at one time possessed these coal royalties. Such, however, is far from being the case: the State, or rather the Crown, in the past repeatedly claimed the ownership of metalliferous minerals, but never at any time set up the slightest claim to an ownership of coals.

Ownership of land and all that pertains to land in England dates from the Norman Conquest, and it is significant that the Doomsday Book, though it mentions other mines, never once mentions a coal mine, so that it may fairly be inferred that at the date of the Conquest no coal mines existed in England. The earliest document concerning coal mines of which we have any knowledge is a Scotch deed dated 1202, in which the superior granted a lease of certain collieries in Newbattle, and even at this period the absolute right of the land-owner to dispose freely of his coal appears to have been unquestioned, and has remained so until the present day. As stated by the Commissioners, the Great Case of Mines settled the rights of the land-owner to mines within his land, as has been very clearly set forth by Sir John Pettus in his *Fodinæ Regales*, published in 1670. Apparently the first mention of coal mines in legislation appears to have been in the well-known Statute of Elizabeth in 1601, which instituted the Poor Rate and empowered the overseers of the poor to levy such rate upon any occupier of lands, houses, *coal mines*, etc. It is highly significant that this Act excludes other mines from the operation of the Poor Rate, and assimilates coal mines to houses and other appurtenances of the land. In England, therefore, the State never parted with the ownership of coal mines, for the simple reason that it never owned them, and it is obvious that if it now wishes to acquire them, it can only do so by purchase. The Commissioners suggest that a purchase price of 100,000,000*l*. would be a fair equivalent; this price is only sufficient if royalty owners consent to accept a lower income than they are at present receiving on condition that it shall be in a more secure form, and the suggestion is not an unreasonable one.

Whilst the principle of State acquisition of royalties is clear enough, its execution bristles with difficulties, not a few of which the Commissioners, to do them justice, have foreseen and have endeavoured in part to meet. The principle which they propose, namely, that coal, the existence of which is not to-day proved, shall belong to the State, is a perfectly defensible one, though curiously enough they have missed the main argument in its favour. It is certain that such coal can only be discovered as the result of the exact knowledge of the geological structure of the country, which has been obtained by the labours of a public department, namely, the Geological Survey, to the maintenance of which every taxpayer has contributed. It is difficult to see why a Kentish farmer who has bought land purely for agricultural purposes should claim the ownership of the coal which happens to lie under that land, when he has contributed to the discovery of that coal nothing more than has an equally taxed person in any other part of the country.

The Commissioners have evidently realised, as every one who knows the industry must realise, that, if it is to survive, the cost of production must come down, and as two-thirds of this consists of wages, it is obviously here that the greatest economies are possible; of the alternatives, either of lowering wages or of increasing the hours of labour for the same wage, the Commissioners pronounce in favour of the former. It does seem, however, that they have not looked at the question of length of the working day from the proper point of view. Their main argument against increasing the length of the working day is that if it were so increased in Great Britain as to be brought up to the level of our principal competitors, these would immediately increase the length of their working day. Obviously the same argument might apply to a lowering of wages, but there is not a particle of evidence that anything of the kind would happen

Surely the proper way to approach the question of the length of a working day is to determine whether an increase of hours would unduly overtax the workers. Those who remember that, not so many years ago, the length of the working day was something like 50 per cent. more than it is to-day, and that men engaged in the even more arduous work of metal mining to-day work longer hours than coal miners, would unhesitatingly declare that the length of the coal miners' working day could be lengthened without inflicting the slightest hardship upon them. There is another alternative which never seems to have been placed before the Commissioners; even if it be suggested that a man who is hand-hewing in hard steam coal for six and a half hours has done as much physical work as can fairly be expected of him, the same cannot be said of the man whose work is running a coal-cutter, and it would appear to be a wise policy to have recommended that the hours of the men working in machine-cut faces should be lengthened. No doubt such a recommendation would present certain difficulties in practice, especially in mines where some districts are hand-cut and others machine-cut, but these difficulties would not appear to be insuperable. The recommendation would have the advantage of more nearly equalising the demands made upon the men, and it would encourage the more extensive use of machinery underground, because it would thus enable owners who put in machinery to get a better return on the capital thus invested.

It is rather surprising to find that in the chapter on profits, as indeed throughout the report, the wasting nature of the industry is nowhere recognised, and the fact is missed that it is necessary to make provision for the capital sunk in a colliery which must be replaced out of revenue before anything like a profit can be earned. The Commissioners estimate that to purchase the collieries of Great Britain would cost 350,000,000*l*.; as the annual output of the country may be averaged at 250,000,000 tons, this amounts to a capitalisation of 28*s*. per ton per annum. If it is assumed, as the Commissioners appear to suggest, that the average life of a colliery may be expected to be about forty years, it is not difficult to calculate what sinking fund would be required to replace the above capital. Assuming the interest on gilt-edged securities to be 4½ per cent., and that income-tax remains as at present 4*s*. in the *l*., the annual amount to replace the capital outlay would be as nearly as possible 4*d*. per ton, thus reducing the real profit from the figure of 1*s*. given by the Commissioners to 8*d*. Furthermore, the Treasury most unjustifiably charges income-tax on the aforesaid 4*d*., although, as just pointed out, it is not profit at all but merely a replacement of capital, so that the nominal profit of 1*s*. is thus cut down to 7*d*. Incidentally it may be suggested that if the Treasury were to refrain from collecting income-tax, which is strictly speaking a tax on profits, from that portion of the income of colliery owners which serves only to replace the capital sunk in the collieries, the nucleus of a fund could be formed which might help to tide the industry over difficult times.

Probably the most difficult point which the report discusses is the problem of what the industry is to do in May next. The Commissioners are quite clear on the point that the subsidy must not be renewed in any form whatever, and the figures which they present make their reason abundantly clear. It is shown that the subsidy has been employed to pay hewers at the high rate of 76*s.* per week on the average, or as much as 90*s.* per week in some districts, whilst it has enabled certain collieries to make quite handsome profits. It is clear enough that neither wages on so high a scale as this nor dividends to shareholders in collieries ought ever to be paid out of the pockets of taxpayers. It is, however, very difficult indeed to see how the industry is going to tide over the next few months without assistance of some kind, because the returns from the industry itself are not sufficient to pay what may be considered a reasonable wage to the lower paid men. The Commissioners, like all intelligent men, realise that the only wages which any industry can pay in the long run are the proceeds of the industry itself, although the Commissioners have not always expressed this clearly; for example, in discussing the policy of the subsidy, they speak of a gap " between the amounts that employers are willing to pay and the amounts that the workers are willing to accept "; it is not a question of what the employers are willing to pay but what they are able to pay; it cannot be too often repeated that the employers do not find the money wherewith to pay wages, they are merely the medium through which the money realised by the industry is handed over to the workers.

The Commissioners realise fully that if the various recommendations which they make are carried out, and if they have, as they well may have, the desired effect of re-establishing the industry, this will be a matter of time, and they do not indicate how the industry is to exist meanwhile. It is possible that some means might be found of tiding over the period of struggle which lies before the industry by an advance from the State, say on the joint guarantee of repayment by the Miners' Federation and the Mining Association, such advances to be used solely for keeping the wages of the lower paid men above subsistence level and not to pay high wages to the higher paid men or dividends to the colliery owners.

In any case, and whatever is done, all engaged in the coal industry must make up their minds to bear their share of the hardships which will have to be faced. As the Commissioners point out, the War has to be paid for, and they show " how impossible it is to insist that real wages shall in no case be below those ruling before the War." Men in the sheltered industries have been able to secure this unfair advantage, and have thus thrown an additional burden on those engaged in the competitive industries, and there seems no alternative but for the latter to shoulder it. Whilst in the words of the Commissioners in discussing the coal industry " the only generalisation about it that is safe is that no generalisation is possible," this much is certain: neither the Commissioners nor any one else can find any royal road by which the industry can be brought to the desired condition of prosperity, and the only avenue by which that goal may be reached for all engaged in the industry, whoever they may be, is hard work and privation.

H. LOUIS.

Egyptian Archæology.

(1) *The Mummy: a Handbook of Egyptian Funerary Archæology.* By Sir E. A. Wallis Budge. Second edition, revised and greatly enlarged. Pp. xxiv + 513 + 39 plates. (Cambridge: At the University Press, 1925.) 45*s.* net.

(2) *Egyptian Religion and Ethics.* By F. W. Read. Pp. viii + 152 + 6 plates. (London: Watts and Co., 1925.) 4*s.* 6*d.* net.

(1) WHILE Egypt has been fortunate in having a preservative climate and an industrious and artistic people who portrayed all its life, it has suffered by the rise of the Nile bed burying its early habitations under the ground. The prominence thus given to the tombs on the desert, as our main source of information, and the popularity of mummies, has led to a false idea of the importance of the funeral rites. This is further enforced when an encyclopædia of Egyptian usages, like the first volume under notice, is called " The Mummy," though that subject does not occupy a twentieth of its bulk. The greater part of the volume deals with the more interesting subjects of the history and language and the objects of utility; thus the living rather than the dead Egyptian is the object of this work.

A brief running account of the history of the kingdom occupies sixty pages on well-known lines, scarcely touching the long prehistoric ages. The list of principal kings' names in hieroglyphics further fills forty pages. A like space is given to a full recital of the stages in the decipherment of the method of writing, showing how far the different scholars carried it between Akerblad in 1802 and Hincks in 1848; this is illustrated by the finest photograph yet taken of the Rosetta stone. The principal hieroglyphs are listed in twenty-five pages, and rather more is given to a list of amulets and figures of gods, with some account of each. The description of usual tombs and their accessories fills the last hundred pages. Thus the stock subjects are pretty fully dealt with, in the form required by a general reader for reference, without entering on the detail needed by a student. A work of this scope is much needed, and no other single volume fills its place.

The great length and continuity of civilisation in Egypt renders it, perhaps, the most important country for studying the nature of man. It was in continual change, its fashions fluctuating around a norm which varied but slowly; yet it was often invaded by fresh peoples, who in mind and body always became assimilated to its culture, until the last two thousand years. This aspect is scarcely touched on in " The Mummy "; the distinctive changes in the history of the mirror, the head-rest, canopic jars, kohl pots, or beads, which serve as landmarks in archæology, are not noticed. The head-rest is said to support the neck, whereas it fitted close above the ear. Soap is said not to have been known early; but a cake of *suab* is figured along with a wash-basin in the IVth dynasty; the meaning of the name is 'causing to be clean,' and it may well be the origin of our *soap*. The red lip-salve is said not to have been found, but the little balls of soft pale rouge are known in the XIIth dynasty. The scarab beetle is said to be of one kind (p. 271), or of two kinds (p. 278), but five or six different genera are already known. The method of *cire perdue* casting is ignored. Thus a great opportunity has been lost of supplementing the knowledge of forty years ago which is here laid out, and the celebrated discoveries and the books of the last few years are not included. Some twenty slips in matters of fact also need correction.

The author expressly disclaims touching the subjects of art and architecture, and considers that they do not belong to the "professional Egyptologist . . . busy with his texts." To the Egyptian nature their art was, perhaps, more than their language as a national expression; they had a far higher and more complete mastery of form than of writing. To deal with Akhenaten—as here—without a word about his new naturalistic work, and its reflex on his ethics, is to miss the most pervading influence of that astonishing period. The sudden movement of thought was as if the Pre-Raphaelites had become the rulers of England with Comte to dictate the religion. The literature of the time could not express half of what the change would mean. We need to get away from the idea that words are needful to express thought; they are ambiguous, inadequate in scope, inexact in connexion. A good cartoon expresses more than a page of writing; it makes us think in things, and not in words. To write about a people it is needful to think as they did, to become one of themselves; in this Maspero succeeded better than any other writer.

(2) The smaller work by Mr. Read is a more detailed account of one section, the views on religion and ethics, and it claims to "depart widely from the views of recognised authorities." There does not seem to be anything fresh, however, in this account of the gods and the religious texts, and the work forms a convenient and readable introduction to the subject. The incessant formula which begins offering tablets, "An offering which the king gives," is discussed, without noting its social explanation. In primitive societies the chief is supported by food-rents from the estates, which he visits in turn. It would, then, be a gift from the king if he allowed this surplus to be devoted to the service of the dead. A further reason for keeping the formula would be that misappropriation of the offerings would be an offence against royalty. The list of sins is said not to have any principle to be traced in the order of it; but it has been shown to be grouped in fives of a similar nature, and this construction was probably to help memory by learning them on the fingers, like the ten commandments. Mr. Read has a considerable regard throughout for historical development, and treats the changes that are seen in the beliefs with the insight of modern writers, recognising that the Egyptians—like most other people—did not apply logic to the inconsistencies of different faiths.

FLINDERS PETRIE.

Agricultural England and Wales.

An Agricultural Atlas of England and Wales. Made on behalf of the Agricultural Economics Research Institute, University of Oxford. By J. Pryse Howell. (Published by Direction of the Ministry of Agriculture and Fisheries.) Pp. iv+26 maps. (London: H.M. Stationery Office; Southampton: Ordnance Survey Office, n.d.) 10*s*. net.

THIS atlas presents for England and Wales the agricultural statistics published in 1921 for Wales only. It follows the same plan as the earlier publication, except that a separate base map of the market-towns replaces the one on tracing-paper in the atlas of Wales. The new work has thus both the merits and defects of its predecessor, some of the defects being increased by the greater delay in publication.

The parish returns of agricultural statistics for June 1918, plotted in the first instance on maps of the scale 1 : 250,000, have been graphically represented by a quantitative 'dot' method on a scale of 1 : 1,500,000. The effect is to show at a glance the distribution of mountain and heath-land, permanent grass, and arable land, and also the principal crops and live-stock. The greatest value of the atlas lies in this statistical confirmation of general and regional impressions based hitherto only upon experience. Details of soil, relief, climate, and weather, so essential to the individual farmer, obviously cannot be shown, but a generalised soil map might have been prepared in place of, or in addition to, that showing solid geology. Much of northern and eastern England has surface soils of glacial and post-glacial origin, and in the chalk country much variety exists due to greater or less admixture of gravel or clay and flints.

It is unfortunate, too, that a winter census of live-stock could not be shown. In spring and autumn extensive movements of cattle take place. Not only is there the movement between mountain pastures and the valleys, but there is also the transference of stock in autumn to arable lands for fattening. The Midlands and the west supply beef cattle from June to December, the east from January to May. The summer census shows Norfolk as one of the counties with the least number of horned cattle and Leicester as one with the greatest. A winter census map would show a reversal of these positions. For general purposes, the greatest defects arise from the abnormal character of agriculture in 1918 and the changes which have taken place since. That year saw the maximum war effort in food production, and since then there has been a substantial decline both in the acreage of arable land and in certain crops. The general abnormality of 1918 may be seen by the following table:

	Arable Land (1000 Acres).	Wheat (1000 Acres)	Oats (1000 Acres).	Potatoes (1000 Acres).	Cows and Heifers in Milk or in Calf (1000).	Other Cattle (1000).	Ewes for Breeding (1000).	Other Sheep (1000).
1913 . .	11,058	1702	1975	442	2264	3453	6699	10,431
1918 . .	12,399	2557	2780	634	2578	3623	6487	9,988
1925 . .	10,682	1500	1868	493	2713	3450	6397	9,578
Av for 10 yrs, 1915–24 . .	11,503	1988	2237	509	2512	3429	6041	9,316

Three of the principal counties in wheat and milk production give the following figures:

	Wheat (1000 Acres)				
	1912	1913	1918.	1924.	1925.
Essex .	136	128	156	106	96
Norfolk .	136	120	135	99	103
Lincoln .	188	148	224	172	184

	Cows and Heifers in Milk and in Calf (1000)				
	1912.	1913	1918.*	1924	1925.
Chester .	115	111	114	118	127
Lancaster .	138	134	135	142	142
Somerset .	122	120	122	139	138

* Excluding heifers in calf.

The cultivation of sugar-beet may be said to have begun in 1920, and is therefore unnoticed in this atlas, though the acreage has reached nearly 55,000 with a possibility of doubling in 1926.

Nevertheless, with all these limitations, the atlas has great value. It is a permanent record of agriculture as it was in 1918 at the close of the War, and although in an absolute quantitative sense the maps may already be out-of-date, the relative distribution of farm lands, of crops and of live-stock—which is the real value of the atlas—probably still holds true.

Experimental Optics.

Experimental Optics: a Manual for the Laboratory. By Dr. G. F. C. Searle. (Cambridge Physical Series.) Pp. xvi + 357. (Cambridge: At the University Press, 1925.) 16*s.* net.

IT is not often that an original investigator lays aside research work in which he has already established a reputation, and bends the whole of his energy and ability to the art of training others in the spirit and practice of his science. It is, perhaps, particularly rare in that vitally important branch of teaching which has for its province the practical laboratory. There is a certain stimulus in lecturing which makes it a not altogether unwelcome interlude in the day's work; but the demonstrator, who must wrestle year in and year out with errors which remain always the same while students come and go, has no such aid to cheer him in his task. When, however, as sometimes happens, a teacher arises with the faith and insight to find in this too often routine work a suitable outlet for his energy and ingenuity, the results for science are apt to be noteworthy. For, after all, it is in the practical laboratory that the experimental scientist is made or marred. There are many old Cambridge men, teaching or practising physics in various parts of the world, who have passed through Dr. G. F. C. Searle's hands, either as students of the art of experimenting, or as raw beginners in the still more difficult art of teaching practical physics to others, who feel towards him a debt of gratitude the sense of which deepens as the years roll on.

For these no review is necessary. The mere announcement that Searle's "Experimental Optics" is out at last will be sufficient to send them post-haste to the bookseller. They have been waiting for it for a time exactly equal to that which has elapsed since they left 'the class.' They will wish to renew old memories of the time when, having worked conscientiously through six methods of measuring the focal length of a thick lens, they were confronted with the demand that the same processes should be repeated on the telescopic system, or the 'model eye'; to fill up gaps left by the carelessness of youth in now highly prized practical note books; and to see what new experiments have been added to the course since their time. For "Experimental Optics" is not a book written in a hurry to meet some sudden demand. It is the work, we will not say of a lifetime (for we cannot possibly spare Dr. Searle until he has completed this series of laboratory manuals with an "Experimental Heat," and a much-needed "Experimental Electricity and Magnetism"), but certainly the work of many years, and the experiments it describes have been tried out on many generations of students. They are not ingenious suggestions which the author thinks might possibly work. They have been tested and tried, under by no means easy conditions, and have gradually ripened to their present perfection. It is this which gives to these manuals by

Dr. Searle, of which "Experimental Optics" is the latest, their unique value.

It must be confessed that this fact adds somewhat to the difficulties of the present reviewer. It is hard to be correctly calm and critically cool towards a book with some parts of which, in their manuscript form, one has that intense familiarity which comes from actual use in teaching in times past. Its qualities, good or bad, are known with an intimacy which is unbecoming to a reviewer. It says something for the quality of the book that, on re-reading these familiar portions after some long interval, its merits seem even greater than we had remembered, and its defects so few as scarcely to call for comment.

Dr. Searle's method of treating his subject is now well known from his previous books, and "Experimental Optics" does not differ in plan from its predecessors. It is written around the experiments, some seventy in number, which make up the course in practical optics in Dr. Searle's class at the Cavendish Laboratory. Many of these experiments are highly original, and they are described with such care and precision that the reader should have no difficulty in following them out, even in their minuter details. The apparatus is usually of the simplest, such as, for the most part, can easily be constructed in a very modestly equipped workshop (a consideration by no means to be despised in these days when prices are high and funds are meagre), and adequate instructions are given for its construction. The accuracy of measurement obtainable is, however, high, as is shown by the practical examples appended to each experiment, which are usually a record of the work of some student in the class. Dr. Searle's ingenuity and experimental skill is nowhere shown more clearly than in the way in which, by ingenious devices and skilful arrangement, he makes it possible even for the ordinary student to obtain results with this simple apparatus which would not be discreditable in a laboratory equipped with the most elaborate and expensive optical devices. No experiment is left until the utmost accuracy of which it is capable has been extracted from it. Experimental optics is not one of the most popular branches of physics at the moment, but there is no part of the subject which is better calculated to instil that meticulous care and precision in measurement which is now, as always, the basis of physics. A student who works conscientiously through the course described in this book will have learned something greater than practical optics: he will have learned how physical experiments ought to be carried out.

The book, however, is more than a practical manual. The theory involved in each experiment is very adequately dealt with either in an introductory paragraph or in a separate chapter. We have thus an excellent treatise on geometrical optics, written, moreover, in a style which brings it within the range of students whose mathematical equipment is not of the strongest. These theoretical sections are, in fact, exceptionally well done. Personally we feel some regret that Dr. Searle should have followed the "lens manufacturers, opticians, and oculists" in assigning a positive focal length to a thin converging lens, instead of following the practice most commonly adopted in mathematical and physical text-books of assigning a negative value to this quantity. Nearly all students will have learned the latter convention before commencing to read Dr. Searle's manual, and though the introduction of a new convention may provide useful food for thought to a good student, weaker students are almost sure to find it disconcerting, and a little confusing.

In scope the book covers adequately, or even more than adequately, all that a student of physics (as distinct from the technician) will require in geometrical optics. In comparison, the section on physical optics, which occupies less than one-quarter of the whole, seems rather scanty. To devise simple apparatus which will permit of even approximately accurate measurements in interference and diffraction is by no means easy, and we are grateful to Dr. Searle for showing us how, in one or two cases, it can be done. We hope he will find it possible to give us more on this branch of the subject, as these two concluding chapters are as interesting and illuminating as anything in the book.

We have here, then, a text-book on optics, accurate, practical, and original, which every teacher will wish to have, and which, we predict, will find a place in every physics laboratory. Unfortunately, it seems impossible nowadays to publish scientific books at a price which the average student can afford to pay, but we are sure that no student who can contrive to add this volume to his library will have cause to regret his purchase.

J. A. CROWTHER.

Quantitative Biology.

Physical Chemistry in Biology and Medicine. By Prof. J. F. McClendon and Prof. Grace Medes. Pp. 425. (Philadelphia and London: W. B. Saunders Co., 1925.) 21*s*. net.

IN the heyday of evolutionary biology, Francis Galton remarked "that until the data of any branch of human enquiry have been submitted to measurement, it cannot be said to have acquired the dignity of a science." It is strange to think that after thirty years the truth and the falsity of this remark are apparent to all except that branch of the biological public to which it was most particularly addressed. To suggest to a physiologist or to a biochemist that an adequate treatment of his subject is possible without a knowledge of physical chemistry, is as ludicrous as to suggest to a student of heredity that a solution of all his difficulties is to be found in the pages of *Biometrika*. Until recently, however, those sciences most closely associated with Galton and with the idea of evolution have shown little tendency to evolve new methods, and little tendency to acquire the 'dignity' which Galton hoped would grace their later years.

The advance of zoology, for example, has been due to the theory of evolution and to the description of animals at all stages of their life-history, and when we view this imposing contribution to human knowledge, we may perhaps regard the acquisition of further complexity with doubtful pleasure. Yet whether we like it or not, Galton's remark was made to all biologists, and it is for them to refute or affirm. So long as we are content to describe the structure of an organism and draw therefrom a mental conception of its evolution, the realm of zoology will be a peaceful haven for all who enter. But if we wish to regard an animal as a real and dynamic system, and if we wish to apply some logical test to our conclusions as to how it lives and how it evolved, then we must use those methods which are available for the study of *changing* systems, whether these be alive or dead.

The study of life is the study of change, and we can either speculate or we can proceed by logical methods placed in our hands by other sciences. One ventures to think that the pathetic striving of the young zoologist for an accurate measurement of his data is a natural reaction from the speculative hypotheses of the past. His problems are not new, but it is by new methods that he seeks to answer old questions. Like all other fledglings, he has difficulties and disappointments. He grasps the delicate instruments of physical chemistry and finds they may break in his hands. He uses a mathematical notation, and only slowly does he learn its value and its limitations. By far his greatest problem is to choose his weapons with discretion and to learn their use. If Prof. McClendon is to be believed, these weapons vary from a knowledge of the electron to a knowledge of higher mathematics. This is indeed a terrifying thought, and this book may well repulse even the most intrepid reader. With breathless speed the authors lead us across wide fields of learning. There is no time to acquire knowledge or to see the great and real difficulties; there is only time to note the valuable lists of references which close each chapter.

We do not think that this book will help those who—according to the preface—" fail to receive early training which they later feel the need of." Nor do we think that it will greatly help the specialised research worker; the material is too scanty and the treatment is too vague. The real value of this and similar books is that they throw out, once more, the challenge to biology to support its speculations by experiments and to acquire more quantitative 'dignity.'

J. G.

Our Bookshelf.

Handbuch der Zoologie: eine Naturgeschichte der Stämme des Tierreiches. Begründet von Prof. Dr. Willy Kükenthal. Herausgegeben von Dr. Thilo Krumbach. Erster Band: Protozoa, Porifera, Cœlenterata, Mesozoa. Sechste Lieferung. Pp. 737-896. Siebente (Schluss-) Lieferung. Pp. 897-1060+xiv. 12·40 gold marks. (Berlin und Leipzig: Walter de Gruyter und Co., 1925.) 9 gold marks.

THE sixth part of this work opens with an account of the pennatulids which, as would be expected from the pen of the late Prof. Kükenthal, is a thoroughly sound piece of work. One of the few points which permits of criticism is the statement that observations on regeneration are wanting; the work of Torrey and of E. B. Wilson on regeneration in young Renillas was evidently overlooked. The chapter on Octocorallia (anemones, corals, etc.) is by Prof. F. Pax and gives a good account of the structure, biology, and classification. The description of the nervous mechanism is, however, disappointing; it is too general, does not get down sufficiently to facts of detail, and there are no illustrations of the nerve elements.

The seventh part is devoted to accounts of the Ctenophora and the Mesozoa. The editor, Prof. T. Krumbach, has undertaken the preparation of the chapter of 90 pages on the Ctenophora and has produced an admirable account of the structure, biology, geographical distribution, and classification of this class. The diagrams illustrating the structure, the variations in form of different genera, the origin of the creeping habit (*e.g.* in Ctenoplana), and the more detailed figures, many drawn from recent memoirs, afford excellent support to the text, but a better figure illustrating the details of cleavage and early development should have been given. The numerous views which have been put forward by different authors on the affinities of the Ctenophora are exhaustively set forth, even the relationships with sponges; a critical discussion and summary of the matter would have been helpful.

Prof. M. Hartmann describes the Mesozoa (17 pp.) and adds a short account of the imperfectly known genera Neresheimia and Salinella. In his account of the Mesozoa he has omitted to refer to the important contributions of Caullery and Lavallée (1912) and of Lameere (1916, 1917, 1919) which add new facts, and offer new interpretations, that should have received notice in a work of this kind.

The seventh part, completing the first volume of the work, contains a full index thereto and a short notice in remembrance of the late Prof. W. Kükenthal. The volume has, in our opinion, improved in quality, in both text and illustrations, in its later parts, and if the rest of the work can be maintained at the high standard attained in most of the recent chapters, it will certainly be an admirable text-book of descriptive zoology for teachers and advanced students.

Hephæstus: or, The Soul of the Machine. By E. E. Fournier d'Albe. (To-day and To-morrow Series.) Pp. 90. (London: Kegan Paul and Co, Ltd.; New York: E. P. Dutton and Co., 1925.) 2*s.* 6*d.* net.

THE publishers make claim for the "To-day and To-morrow Series" that it has revived the pamphlet as a form of literature. Now a pamphlet, one supposes, should be brief, provocative, and readable. If the author is a little angry, all the better; Milton was angry when he wrote the "Areopagitica" and his treatises on divorce. If the author has several very obvious blind spots, all the better; some one else will immediately write another pamphlet to point them out to him; and so the joyous game of pamphleteering will grow like a snowball.

Dr. Fournier d'Albe is brief, provocative, and readable, but not angry; he is lyrical. His pamphlet is a pæan in praise of the machine, daughter of Hephæstus and Fire, liberator of mankind. "The victories of Hephæstus are victories of mind over matter. The *mechanical age*, which to some appears as the very negation of the soul, is, on the contrary, the age of supreme psychical achievement" (p. 50). "Fire has made all things new" (p. 57). "The whole earth must be Vulcanized" (p. 80). So the European. We may now confidently await the pamphleteer, with sympathies more Asiatic than European, with mind given pause by the speculations of, say, Spengler, who will point out to Dr. Fournier d'Albe that nine-tenths of mankind are still, always have been, and probably always will be, supremely indifferent to, and slightly contemptuous of, any but the most rudimentary form of machine. Modern European civilisation is built on machinery; other civilisations have had other foundations.

J. Y. T. G.

An Introduction to Organic Chemistry. By Prof. Alexander Lowy and Dr. Benjamin Harrow. Pp. ix+389. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 15*s.* net.

BOTH the teacher and student of organic chemistry must at times seem overwhelmed by the enormous and ever-growing mass of material that now constitutes this branch of the science; but, fortunately for both, the subject is well systematised and lends itself well to a broad, general treatment. The work under review can be recommended from this point of view: the outline presented is broad and clear, structural formulæ are numerous and well set out, especial prominence is given to applications in the industrial arts, biochemistry, and pharmacy, and the parts dealing with nomenclature and the meanings of technical terms are very useful.

Although the method of presentation is, in general, not sufficiently didactic for use in secondary schools, and is inclined to be too dogmatic, fact and hypothesis being inadequately differentiated, the book will serve as an excellent introduction for students when used as an auxiliary to a good course of lectures and experimental work. The exclusion from the main body of the text of melting- and boiling-points, and similar physical details, the up-to-date character of the subject matter, and the insertion of some excellent folding charts relating mainly to industrial applications, all help to make the work thoroughly readable and to awaken the interest of the student. The literature references given throughout the book, with the view of inciting collateral reading, add considerably to its value.

Dwellers of the Sea and Shore. By William Crowder. (Hutchinson's Nature Library.) Pp. xv+300+44 plates. (London: Hutchinson and Co., n.d.) 7*s.* 6*d.*

"DWELLERS OF THE SEA AND SHORE" is a true natural history book, and is written by a real naturalist who obviously delights in observing the living animals and plants in their haunts. Although it is published in England as one of "Hutchinson's Nature Library," the reader will not find in it an account of the inhabitants of British shores and seas. The region described is on the American coast not many miles from New York Harbour, and although we have many seashore animals and plants in common, there are of course many differences. This is perhaps really an advantage, as we are given an excellent picture of a foreign shore. The illustrations are good, especially the photographs of living animals taken in the water, and the extremely interesting pictures of the king crab. The chapters on the habits of the individual animals remind one of Fabre, those on the king crab, fiddler and hermit crabs, and the moon snail having a peculiar charm. We gather from the author the sad fact that Limulus, the "living fossil" as he terms it, is in danger of extinction in spite of its great abundance. There is little to criticise in the book, which is a genuine contribution to the biology of sea animals, but why should it be said that brachiopods differ from bivalve molluscs in having both valves similar?

A Summary of Physical Chemistry. By Prof. K. Arndt. Translated from the fourth German edition by W. H. Patterson. Pp. v + 92. (London: Methuen and Co., Ltd., 1925.) 3*s.* 6*d.* net.

THE "Summary of Physical Chemistry" which Mr. Patterson has translated covers 86 pages, apart from the two indexes. It is just the sort of abstract that an able student would prepare in order to recall the essential points of the lectures to which he had listened, and of the text-books which he had read. A ready-made summary of this kind provides a means of 'spoon-feeding' which is likely to be acceptable to many hard-pressed students, but in the opinion of the reviewer they would be well advised to make use of it only after compiling a summary of their own, and then mainly in order to check the completeness of the 'home-made' product. If used in order to provide a supply of 'catch-words,' as a substitute for detailed knowledge, its introduction would be definitely harmful.

An Introduction to the Physics and Chemistry of Colloids. By Emil Hatschek. (Text-books of Chemical Research and Engineering.) Fifth edition. Pp. xiii+183. (London: J. and A. Churchill, 1925.) 7*s.* 6*d.* net.

THE first edition of Hatschek's "Introduction to the Physics and Chemistry of Colloids" appeared in 1913. Since the fourth edition was entirely rewritten, the fifth edition includes only a few additional sections describing recent important advances; apart from these, the text is substantially that of the previous edition.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

International Phenology.

OUR appeal in NATURE of October 25, 1924, and April 25, 1925, for international phenological co-operation has met with unexpected response. We now know that, on the continent of Europe alone, apart from individual workers, networks of observing stations have been established in the following countries:—Holland, under Dr. H. Bos; Belgium, under the late Prof. Vanderlinden; Norway, under Asche Moe; Germany and Austria, under Dr. E. Ihne; Czecho-Slovakia, under Prof. J. Kopecky; Hungary, under Dr. J. Schenk, Tyrol, under Dr. W. Pfaff; North Italy, under Dr. M. A. Minio; Russia in Europe, under Prof. P. Schmidt. Of these, we had previously only been in touch with Holland, Belgium, and Germany.

The total number of stations exceeds two thousand, besides more than three hundred and fifty in the British Isles. Dr A. D. Hopkins carries on similar and more organised work in the United States, and it is developing in western Canada. Numerous isolated observers in Europe and in the more distant British Dominions, Java, etc, are in touch with us. Agricultural colleges are participating more and more as they realise the practical value of phenology.

In order to develop closer co-operation and greater uniformity in method, some suggest holding an international congress and founding a periodical. We are further indebted to Prof. Paul Pelsener, of Brussels, who, at the International Conference of Biological Sciences held there last July, presented our appeal and obtained a resolution recommending their branches in their respective territories to organise phenological work analogous to that of the Royal Meteorological Society.

These results are gratifying, even if conditions are as yet scarcely ripe for a special congress or periodical. But with the help of NATURE we should like to present a definite scheme for observations, based on the valuable criticisms of the suggested list of 43 plants given in last communication. This we have condensed to about 30, and associated with them a few observations of birds and insects, all as tabulated below.

SUGGESTED PHENOLOGICAL SCHEDULE FOR INTERNATIONAL OBSERVATIONS.

	Plants.		Day of Year.
1	*Galanthus nivalis**	Snowdrop	19
2.	*Eranthis hyemalis**	Winter Aconite	20
3.	*Crocus aureus**	Yellow Crocus	33
4.	*Ulmus campestris*	Common Elm	44
5.	*Corylus avellana* ♀ (Female)*	Hazel	44
6.	*Ranunculus ficaria**	Lesser Celandine	47
7.	*Tussilago farfara**	Coltsfoot	65
8.	*Prunus amygdalus*	Almond	85
9.	*Anemone nemorosa**	Wood Windflower	92
10.	*Prunus spinosa**	Blackthorn	102
11.	*Quercus pedunculata*	Stem-seeded Oak	115
12.	*Ribes rubrum*	Red Currant	115
13.	*Alliaria officinalis* or *Sisymbrium alliaria**	Garlic Hedge Mustard	120
14.	*Pyrus malus*	Wild Crab-apple	130
15.	*Syringa vulgaris**	Common (purple) Lilac	130
16.	*Æsculus hippocastanum*	Horse Chestnut	133
17.	*Prunus padus*	Bird Cherry	135
18.	*Cydonia vulgaris*	Quince	135
19	*Cytisus laburnum*	Laburnum	138
20*a*.	*Crataegus oxyacantha**	Hawthorn	139
20*b*	,, *monogyna*	Southern Hawthorn	145
21.	*Chrysanthemum leucanthemum**	Ox-eye Daisy	154
22	*Sambucus nigra*	Elder	160
23.	*Rosa canina**	Dog Rose (pink)	163
24.	*Symphoricarpus racemosus*	Snowberry	165
25.	*Robinia pseudacacia*	White Acacia	190
26.	*Lilium candidum*	Madonna Lily	195
27.	*Castanea vesca*	Sweet Chestnut	200
28	*Scabiosa succisa**	Devil's-bit Scabious	220
29.	*Colchicum autumnale*	Autumn Crocus	245
30.	*Hedera helix**	Ivy	276
31.	*Helleborus niger*†	Christmas Rose	350
	Birds.		
A.	*Turdus musicus* (Song Thrush), in song after Dec 31.		22
B.	*Phylloscopus rufus* (Chiffchaff), heard		95
C.	*Hirundo rustica* (Swallow), arrives		109
D.	*Cuculus canorus* (Cuckoo), heard		114
E.	*Cypselus apus* (Swift), arrives		125
F.	*Muscicapa grisola* (Spotted Flycatcher), arrives		135
G.	Last *Hirundo rustica* (Swallow), leaves		283
	Insects.		
J.	*Apis mellifica* (Honey Bee), visiting flowers		60
K.	*Vespa vulgaris* (Queen Wasp), flying in open		103
L.	*Pieris rapae* (Small White), flying in open		111
M.	*Anthocaris cardamines* (Orange Tip), flying in open		131
N.	*Epinephile janira* (Meadow Brown), flying in open		164

The dates are the average for the thirty years 1891 to 1920 in the British Isles. The plants marked *, and all the birds and insects, are on the British Schedule.

† To be entered on the schedule for the following year

The following, among other points, have governed the selection, after careful comparison of lists from the above nine countries and our own.

(1) That each country may find among them at least ten to twenty plants which are easily accessible. The birds and insects are well distributed over Europe.

(2) That at least a few, as garden growths or wild, shall be found in all temperate regions. Tropical countries it seems most difficult to include.

(3) That the whole phenological year shall be covered. Where observers can undertake the work, we commend further observations, especially with trees, on the date of leafing (trees look green), fruiting, colouring (full tint), and leaf-fall (trees bare). All who can are asked to do this at any rate for *Æsculus hippocastanum*.

(4) For flowering date it is advantageous to select such as bloom quickly, when once buds begin to open.

The stage at which flowering is recorded varies very awkwardly in different countries We suggest the selection of tree, bush, or herb, or better still, a group, situated in the most normal exposure available, neither exceptionally early nor late in maturing, and that on such plant or group the first flower to expose its stamens (or *pistils* for *Corylus avellana*) shall be recorded *if—and only if*—the other buds are about to do the same.

The observer's district should be as concentrated as possible. A five-mile radius should be regarded as the limit, and elevation above sea-level differ as little as possible.

The same plant or group should be observed from year to year, or of herbs a selection from those under similar conditions.

Where they can, British observers are invited to include part or all of the extra plants in a supplementary table.

We wish again to make it clear that there is at present no central body to collect and, above all, tabulate results. This must be done by each country independently, after having circulated to their observers such a list, selected from that subjoined, as best adapts itself to local conditions, including the same as part of, or as supplement to, their present schedule. All the lists sent us already include quite a large number.

In the course, say, of ten years, we may well hope that these records will be collocated and produce, directly and by correlation, interesting data for scientific analysis and also of value for agricultural and other practical applications

Long before then we might have preliminary annual comparisons on special events, and even pan-European isophenal charts, such as Hoffmann and Ihne have given us for much of western Europe.

As an initial step, and by way of a practical experiment, we suggest the preparing by each network of stations four isophenal charts of their area for 1926, namely, one each for *Prunus spinosa* (102), for *Hirundo rustica* (109), *Pieris rapae* (111), and *Cuculus canorus* (114), sending a copy to our Committee, that each of the four may be combined to form one of Europe. The interest would lie in investigating how far the relative dates in one part of the continent held from region to region.

Finally, we would appeal again to the other British Dominions, especially in the sub-continent, asking them in their countries also to collaborate so far as possible with the older countries in this work.

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Zoological Nomenclature.

THE Secretary of the International Commission on Zoological Nomenclature has the honour to announce the publication of Opinions 82 and 90, rendered by the International Commission on Zoological Nomenclature, by the Smithsonian Institution in *Smithsonian Miscellaneous Collections*, vol. 73, No. 3, pp. 1-40. The summaries read as follows:

Opinion 82. Suspension of Rules for Musca Linnæus, 1758a, type *M. domestica*. By authority of the power conferred on the Commission by the ninth International Congress of Zoology to suspend the Règles as applied to any given case where in its judgment the strict application of the Règles will clearly result in greater confusion than uniformity, Article 30 is hereby suspended in the case of Musca Linnæus, 1758, and *Musca domestica* Linnæus, 1758, is hereby designated as type of Musca without prejudice to other cases.

Opinion 83. *Acanthiza pyrrhopygia* Vigors and Horsfield, 1827, versus *Acanthiza pyrrhopygia* Gould, 1848. The principle of the Rule of Homonyms is that any properly published identical name of later date is "stillborn and cannot be brought to life." *Acanthiza pyrrhopygia* Vigors and Horsfield, 1827, invalidates *Acanthiza pyrrhopygia* Gould, 1848.

Opinion 84. Trematode, Cestode, and Acanthocephala names placed in the Official List of Generic Names. The following names are hereby placed in the Official List of Generic Names: Trematoda: Dicrocoelium, Fasciola, Gastrodiscus, Heterophyes. Cestoda: Davainea, Dipylidium, Echinococcus, Taenia. Acanthocephala · Gigantorhynchus.

Opinion 85. Ninety-eight generic names in Crustacea placed in the Official List of Generic Names. The following names are hereby placed in the Official List of Generic Names: Crustacea: Acmaeopleura, Asthenognathus, Bathyplax, Camptandrium, Camptoplax, Catoptrus, Ceratoplax, Chasmagnathus, Chasmocarcinus, Clistocoeloma, Cyrtograpsus, Dissodactylus, Durckheimia, Epixanthus, Euchirograpsus, Eucrate, Eucratodes, Eucratopsis, Euryetisus, Euryplax, Eurytium, Fabia, Galene, Geryon, Glyptograpsus, Glyptoplax, Gomeza, Goneplax, Halimede, Helice, Hephthopelta, Hexapus, Holometopus, Holothuriophilus, Homalaspis, Lachnopodus, Leptodius, Liagore, Libystes, Liomera, Lipaesthesius, Litocheira, Lophopanopeus, Lophopilumnus, Lybia, Melybia, Metasesarma, Metopocarcinus, Micropanope, Notonyx, Oediplax, Ommatocarcinus, Opisthopus, Orphnoxanthus, Panoplax, Paragalene, Parapanope, Parapleurophrycoides, Paraxanthus, Percnon, Perigrapsus, Pilumnoides, Pilumnus, Pinnaxodes, Pinnixa, Pinnotherelia, Pinnotheres, Planes, Platychirograpsus, Platypilumnus, Platyxanthus, Polydectus, Prionoplax, Pseudocarcinus, Pseudopinnixa, Pseudorhombila, Psopheticus, Ptychognathus, Pyxidognathus, Rhithropanopeus, Rhizopa, Ruppellioides, Sarmatium, Scalopidia, Scleroplax, Speocarcinus, Sphaerozius, Tetraxanthus, Tetrias, Thaumastoplax, Utica, Varuna, Xanthasia, Xanthodius, Xenophthalmodes, Xenophthalmus, Zosimus, Zozymodes

Opinion 86. Conulinus von Martens, 1895. The generic name Conulinus von Martens, 1895, takes as type *Buliminus* (*Conulinus*) *conulus* Rv, and is not necessarily invalidated by Conulina Bronn.

Opinion 87. The status of proof-sheets in nomenclature. Printer's proof-sheets do not constitute publication, and therefore have no status under the International Rules of Zoological Nomenclature.

Opinion 88. *Otarion diffractum* vs. *Cyphaspis burmeisteri*. The name of a species is not disqualified merely because the author included in his conception bodily parts of more than one species. The name of a genus based on such a species is therefore available *Otarion diffractum* Zenker is valid. Otarion is to be preferred to Cyphaspis, and *C. burmeisteri* Barr. is a synonym of *O. diffractum*.

Opinion 89. Suspension of the rules in the case of Gronow 1763, Commerson 1803, Gesellschaft Schauplatz 1775 to 1781, Catesby 1771, Browne 1789, Valmont de Bomare 1768 to 1775. Under suspension of the rules, in any case where such suspension may be considered necessary according to the interpretation now or hereafter adopted by the Commission, the following works or papers are declared eliminated from consideration as respects their systematic names as of their respective dates: Gronow 1763, Commerson 1803, Gesellschaft Schauplatz 1775 to 1781, Catesby 1771, Browne 1789, Valmont de Bomare 1768 to 1775.

Opinion 90. Report on sixteen generic names of mammals for which suspension of rules was requested. None of the sixteen names receives a unanimous vote for suspension; accordingly, the Commission is not empowered to suspend the rules for these cases. Six names (namely: Cercopithecus, Gazella, Hippotragus, Lagidium, Nycteris, and Manatus) receive two-thirds majority or more for suspension, and are, therefore, to be referred for final decision to a special committee of three to be appointed by the president of the section on nomenclature of the next international congress. Ten names (namely: Echidna, Anthropopithecus, Coelogenys, Chiromys, Dasypus, Dicotyles, Galeopithecus, Hapale, Rhytina, and Simia) fail to receive a two-thirds majority vote for suspension, and therefore the law of priority is to be applied in these cases C. W. STILES (Secretary).

International Commission on Zoological
Nomenclature.

The Isomeric Chromic Chloride Hexahydrates.

THE Werner formulation for the dark-green chromic chloride hexahydrate, namely, $[CrCl_2(H_2O)_4]Cl,2H_2O$, has been criticised recently by Britton (*J. Chem. Soc.*, 1925, 127, 2128), who offers the alternative view that the basic chromium complexes apparently present in green solutions are "micellar" in structure and virtually constitute a colloidal electrolyte in which the cations are composed of chromium hydroxide and varying amounts of acid radical, a portion only being ionisable. This view accounts for the fact that green salts show greater resistance towards alkali than the analogous violet modifications.

In an endeavour to confirm the Werner formulation for the three chromic chloride hexahydrates, we had commenced a series of viscosity determinations on aqueous solutions of these salts. Three such hydrates are known:

Name.	Colour.	Werner Formula.
Hexa-aquo chromic chloride .	Violet	$[Cr(H_2O)_6]Cl_3$
Monochloro-penta-aquo chromic chloride monohydrate .	Blue-green	$[CrCl(H_2O)_5]Cl_2,H_2O$.
Dichloro - tetra - aquo chromic chloride dihydrate . . .	Dark-green	$[CrCl_2(H_2O)_4]Cl,2H_2O$.

The violet hydrate is unstable in the solid state and passes slowly into the dark-green hydrate; the latter, which is stable in the solid state, passes into the violet form in solution. The intermediate hydrate is unstable in the presence of moisture; it changes to the dark-green form, and measurements on its solutions were not attempted.

The comparative flow method of measurement was used, a viscosimeter of the type described by Martin (*Bull. Soc. Chim. Belg.*, 1925, 34, 81) being found to give very consistent readings. Our measurements are summarised in the following table, η/η_{H_2O} representing the ratio of the viscosity of the solution to that of water at the same temperature.

Dark-green Chloride.		Violet Chloride.	
Wt. of Hydrated Salt per 100 gm. of Water.	η/η_{H_2O}	Wt. of Hydrated Salt per 100 gm. of Water.	η/η_{H_2O}.
Temperature 25°.			
50·32	1·8095	62·20	3·3571
35·67	1·5397	33·64	1 9206
21·50	1·3333	20·61	1·4841
16·34	1·2462	17·58	1·3968
12·91	1·1984	16·27	1·3730
6·35	1·1111	11·23	1·2381
3·58	1·0635	8·48	1·1944
		5·75	1·1270
		3·68	1·0793
Temperature 18°.			
52·40	1·8904	40·18	2·1644
36·36	1·5616	26·82	1·6575
24·80	1·3493	16·81	1·4315
22·38 [1]	1·2808	13·57	1·3356
17·07	1·2329	9·44	1·2123
12·79 [2]	1·1507	8·02	1·1849
10·04	1·1166	5·48	1·1164
6·86	1·0890	3·46	1·0753
4·05	1·0548	1·63	1·0342

[1] This was a freshly prepared solution.

[2] This solution was freshly prepared; the subsequent solutions were obtained from it by progressive dilution.

The figures in the fourth decimal place under η/η_{H_2O} are not wholly reliable. The figures for dilutions greater than 5 gm. per 100 gm of water should be accepted with reserve.

The dark-green solution changes to violet with time; it follows that, except for those cases in which solutions have been freshly prepared, the figures for the dark-green chloride are too high. In any case, for equivalent salt concentrations, the viscosities of the violet chloride solutions are much higher than those of the corresponding green solutions.

This is in qualitative agreement with the formulæ assigned to the two salts by Werner. Presumably, the co-ordinated nucleus affords the greater contribution to the viscosity of the solution, and one would expect solutions containing the larger nucleus to be more viscous than those containing the smaller one. In other words, one would expect violet solutions to show a higher viscosity than the analogous green ones; experiment confirms this. On Britton's view the exact opposite should hold, since he considers the green solutions to be colloidal in nature. Endeavours are being made to apply the above results quantitatively.

A paper has recently appeared by Birk and Biltz (*Z. anorg. Chem.*, 1925, 150, 20) in which the molecular volumes in petroleum of the chromic chloride hexahydrates are recorded. The molecular volumes are found to increase with decreasing stability, *i.e.*, in the order dark-green, violet, and blue-green. The molecular volumes of the water in the three salts are given as 14·7, 15·2, and 15·7, respectively. Presumably, therefore, if these figures are correct, the unstable blue-green salt should give solutions even more viscous than solutions of the violet salt.

An X-ray examination of the salts has been commenced with the object, if possible, of elucidating the relative positions of the water in the nucleus and the water of crystallisation, and so forming an ultimate confirmation or negation of the applicability of Werner's ideas to these compounds.

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S. K. TWEEDY.

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February 4.

On Nocturnal Colour Change in the Pea-crab (*Pinnotheres veterum*).

WHILE investigating the moulting stages of pea-crabs, a nocturnal colour change—analogous to that described by Gamble and Keeble in Hippolyte (*Quart. Journ. Micros. Sci*, 1900; *Phil. Trans. Roy Soc.*, B, 1903, 1905)—was observed by me in what is apparently *Pinnotheres veterum*. Last June I received from the Marine Biological Association, Plymouth, an ascidian (*A mentula*) which had been dredged off the Mewstone, and from the branchial chamber of which a pea-crab had been found attempting to escape By the time it reached me two crabs had escaped, a male and a berried female. These are most probably *P. veterum*

P. veterum is the pea-crab which inhabits the Pinna of the Mediterranean and is also found in the large Pinna of the Salcombe Estuary in Devonshire. It has been recorded as well from parts of the Irish coast in Pinna and Modiola *P. veterum*, however, is much less common than *P. pisum*, the pea-crab which is found living within the mussel (*Mytilus edulis*), as well as in other bivalve molluscs.

It so happened that the paper lining of the lid of the jar in which the ascidian and crabs travelled from Plymouth had become sodden and had fallen into the water in numerous small pieces. After the contents of the jar had been turned into a bowl and allowed to rest for a while, it was noticed that the crabs had hidden themselves beneath the paper. When uncovered they proceeded to hide themselves again, sidling under the fragments, and throwing them on to their backs with their legs. The female being of considerable size (11 mm. in width) had more difficulty in hiding itself and made more use of its legs in placing pieces of paper on its back. Occasionally it was seen holding there fragments of paper, and once a tiny empty bivalve shell. The last two or three pairs of legs were used in these operations, and not the chelipeds, as perhaps one might have expected. The dactyli of the legs of this crab are long and curved. When in hiding the antennules were withdrawn.

At night the crabs came out of hiding and were very active. The female appeared at dusk; the male some while, an hour or an hour and a half, later. The nights being very short in June, the crabs were only active for a few hours out of the twenty-four. The more tardy male never showed itself until 10.30 P.M., and was hidden again soon after daybreak, about 5 A.M. Summer Time.

If at night the crabs were brought into the light they almost immediately made efforts to hide themselves. Their activity in the dark was accompanied in the male by loss of colour. In daylight or in a lighted room the dorsal surface of the male crab was a golden brown, shaded with dark brown, and more richly coloured anteriorly than posteriorly. This coloration was due to the presence of orange and dark brown chromatophores, which in this condition were so expanded and their pigment so diffuse as to be almost invisible with a low power of the microscope. In the dark the male became pallid and transparent, the food in the stomach and intestine showing black and the testes white. This loss of colour is due to the retraction of the pigment in the chromatophores induced by the onset of darkness. When the chromatophores were quite contracted some faint yellow diffuse pigment was visible towards the centre of the carapace. The orange pigment appeared to have a quicker rate of flow than the dark brown, and contracted to a smaller area; it is probable that it is lodged in a smaller cell than the dark brown. It appeared as irregular patches of reddish brown or deep orange pigment near the more dendritic or stellate dark brown chromatophores. The ventral surface of the male crab was pale, with very few chromatophores.

The female *P. veterum* had a dirty appearance, but seemed to have no definite colour, and after being in the dark there was no appreciable change in its appearance. I was unable to make out chromatophores in this female, though I have seen them in other adult females which had a definite brown colour.

It is interesting that the male *P. veterum* which suffered nocturnal loss of colour only came out of hiding after it had been really dark some considerable time, while the female appeared at dusk

During the day the experiment was tried of covering the crabs' bowl with something dark. This was done several times, and on a few—but not all—occasions the crabs came out of hiding in about forty to sixty minutes, the male gradually losing colour during this time. When the bowl was uncovered and the crabs exposed to light, the male took about the same time to recover its colour.

The crabs were kept under observation for about forty days. The conditions were unfavourable, for they were kept without change of water and without the addition of food. After about a month the male *P. veterum* failed to react to the stimulus of light, the chromatophores remained expanded at night and the crabs did not hide themselves during the day. It is hoped to continue the observations in the near future.

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Magnetic Storm of February 23-25, 1926.

FEBRUARY 1926 was characterised by rather considerable magnetic activity, there being during the month only four really quiet days, namely, February 6-9. The outstanding feature of the month was the storm of February 23-25, which, as regards duration, was of greater magnitude than that of January 26-27, some aspects of which were discussed in NATURE by Father J. P. Rowland, S.J. It will be noticed that the storms were separated by an interval of twenty-eight days.

According to the Eskdalemuir records, the first movements definitely associated with the February storm began shortly after 23 d 14 h. From about that time until 24 d. 1 h. the geographical north (N) and west (W) components of force were mainly in excess of the normal quiet-day values (as derived from the records on the four days mentioned above), and during this interval fluctuations of considerable magnitude occurred in N and, to a less extent, in W. For several hours after 24 d. 1 h., N and W were definitely in defect of their normal values; the ranges of movement were less than in the earlier part of the storm, but there was very considerable short-period oscillatory movement after about 5 h. From 24 d. 9 h. and 24 d. 13 h., W and N respectively were, on the whole, above normal until about 19 h. Thereafter N remained mainly below normal for several hours, while W was less than normal until shortly after 25 d. 2 h. Irregular disturbance ceased soon after noon on February 25. The largest and most rapid changes in N and W, and the absolute extreme values attained during the storm, occurred during the *post-meridiem* hours of February 24. The times of occurrence of the extreme values were. N: maximum, probably between 16 h. 10 m. and 16 h. 50 m.; minimum, 21 h. 13 m. W: maximum, 16 h. 13 m.; minimum, 21 h. 18 m. The corresponding ranges were: N, >580γ, W, 550γ ($1\gamma = 10^{-5}$ c.g.s. unit).

Vertical (downward) force, V, began to increase from 23 d. 14 h. and remained considerably above the normal undisturbed value during the greater part of the ensuing twelve hours. The sequence of changes during the first part of this interval were somewhat similar to those which occurred in the corresponding stages of the storm on January 26; in particular may be mentioned the broken increase between 16 h. and 18 h. and the two maxima, near 19 h. 30 m. and 21 h. respectively (the earlier being the greater), on each occasion. For about ten hours after 24 d. 2 h. V was below the normal undisturbed value, the lowest value during the first part of the storm being reached at 24 d. 6 h. 44 m. After noon on that day a fairly rapid increase set in. Between 14 h. and 16 h. oscillations of considerable magnitude were superimposed on the general increase. The absolute maximum of the storm occurred between 16 h. 14 m. and 17 h. 42 m., the spot of light passing beyond the limit of the photographic paper during this interval. V decreased fairly rapidly but irregularly between 19 h. and 22 h., and thereafter more gradually to 25 d. 2 h. 40 m., when the minimum value was reached. V was below the normal undisturbed value throughout the interval 24 d. 22 h. to 25 d. 8 h. The recovery from the minimum value was accompanied by pulsations of a few minutes period, but these small changes were less strongly developed than those during the corresponding stages of the January storm. The absolute range in V in the February storm exceeded 560γ.

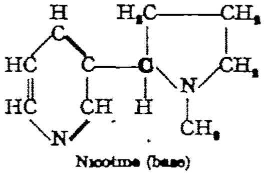
The ranges in N, W, and V during the interval 23 d. 14 h. to 24 d. 12 h., *i.e.* during the earlier part of the storm, were 386γ, 225γ and 314γ, and therefore distinctly less than the ranges in the later part. It will be seen that the storm of February 23-25 reached its greatest development during the second part of its course and so differed from the January storm, in which the extreme values, together with the largest and most rapid changes, occurred during the first thirteen or fourteen hours. The rapidity of the irregular changes during the phase of greatest disturbance was less in the February than in the January storm. In regard to the absolute ranges in the three components in the two storms, exact data are lacking in the case of N and V, for the record was 'off the sheet' in the neighbourhood of either one or both of the extreme values in each case; but it seems probable that the ranges in N and V in the February storm were not greatly, if at all, inferior to those in the January storm. During the latter the range in W exceeded that in the February storm by about 180γ. A rather interesting feature is that in all three components the minima were higher, *i.e.* less in defect of the normal undisturbed value, in the February than in the January storm.

Aurora was not visible from this locality, which was enveloped in low cloud throughout the course of the storm; but reports of aurora observed elsewhere would be of interest. H. W. L. ABSALOM.

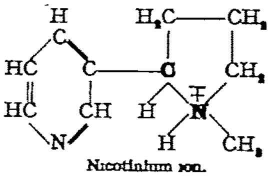
Eskdalemuir Observatory,
March 2.

Asymmetric Nitrogen Atoms in Natural Products.

IT has been generally admitted that, although optical activity can be developed in compounds containing asymmetric atoms of carbon, nitrogen, phosphorus, arsenic, sulphur, selenium, tin, etc., as well as in "centro-asymmetric" compounds in which no asymmetric atom can be detected, all naturally-occurring compounds owe their optical activity to the presence of one or more asymmetric carbon atoms. It is, therefore, somewhat of a surprise to discover that the salts of nicotine contain an asymmetric nitrogen atom, in addition to the asymmetric carbon atom to which the free base owes its optical activity, since it was believed that the former type of asymmetric atom was only to be found in laboratory products. It is nevertheless clear, from the formulæ set out below, that the addition of a proton to the nitrogen atom of the pyrrolidine ring of the base does in fact convert this atom into a quaternary ammonium ion, which is linked to four different radicals, and must therefore be regarded as asymmetric, whatever opinion may be held as to the asymmetry of the tri-substituted ammonia from which it is derived.



Nicotine (base)



Nicotinium ion.

These deductions from the structural formula of nicotine receive a partial verification in the fact that the rotatory power of the salts of nicotine, *e.g.*, $[\alpha]_D = +18{\cdot}85°$ for the acetate, is of opposite sign to, and much smaller than, that of the free base, for which $[\alpha]_D = -169°$. This anomaly is not observed in compounds such as camphorsulphonic acid, where the formation of a salt is not accompanied by any fundamental change either in the character of the asymmetric system or in the optical rotatory power of the acid; but it is well known in alkaloids such as narcotine. Several cases are also known in which the rotatory power of a benzoyl-derivative differs widely from that of the free base.

Further verification of the view set out above is found in the fact that (according to a preliminary series of experiments made by Prof. B. K. Singh) the rotatory dispersion of nicotine acetate is "complex," depending on the superposition of at least two "simple" partial rotations, whereas the base itself exhibits only a "simple" rotatory dispersion (Lowry and Singh, *Comptes rendus*, 1925, 181, 909), thus suggesting that a new partial rotation has been developed on converting the base into its acetate.

A series of additional experimental tests has been arranged, and it is proposed to extend the inquiry to other cases in which an asymmetric nitrogen-atom may be developed in derivatives of an optically-active base. T. M. LOWRY.

Laboratory of Physical Chemistry,
Cambridge, February 4.

Abnormalities produced by Amniotic Pressure, and their Relation to Heredity.

IN his review of Haecker's work on pluripotency published in NATURE of November 28, 1925 (vol. 116, p. 776), Prof. MacBride stated that according to researches of Jansen in Holland, Tornier in Germany, and Sir Robert Jones in Great Britain, polydactyly and brachydactyly are both due to pressure of the amnion on the growing rudiments of the fingers, when too little amniotic fluid is secreted during embryonic development. I know from my own experiments that polydactyly is hereditary, and from the observations of others that brachydactyly is likewise hereditary. Does Prof. MacBride really believe that these abnormalities are produced by mechanical pressure of the amnion on the embryo and are at once in the following generation developed by heredity? Such a belief is contrary to the general trend of all the evidence concerning the question of the heredity of somatic modifications. In the case of lizards it is possible, by cutting off the tail and dividing the stump, to obtain lizards with two regenerated tails, but I have never heard it even suggested that the offspring of lizards so treated develop two tails by heredity.

In his letter in NATURE of February 13, p. 232, Prof. MacBride writes: "we can show in the case of Vertebrata that 'mutations' as apparently diverse in nature as mental defect and supernumerary fingers can be explained as due to varying degrees of abnormal amniotic pressure." This is a contradiction in terms: if the abnormalities mentioned were mutations they would not be due to amniotic pressure, and if they were due to amniotic pressure they would not be mutations.

If the abnormalities to which Prof. MacBride refers are not hereditary, the matter is of little importance, but if he means that they are hereditary, like the abnormalities usually described under the names polydactyly and brachydactyly, it would be interesting to know what is the evidence on which his statements are based. He will probably reply that I can read the evidence in the papers of the authors whose names he has given. But he has not given references to their papers; and, further, he is responsible for his own statements implying or suggesting that a hereditary abnormality (for that is the usual meaning of mutation) may be produced in a single individual by mechanical pressure in the embryonic stage of development. It seems to me that other biologists have a right to ask him either to justify or withdraw his statements. J. T. CUNNINGHAM.

East London College,
Mile End Road,
February 18.

On the Polarised Emission of Mercury Lines.

EXPERIMENTS are in progress in which the mercury spectrum is excited by a directed stream of electrons from an oxide coated filament, and the polarisation of the lines examined. The track of the electron beam in a field-free space at a pressure of 1/1000th mm. is well defined, and little visible light is emitted from points not in the path of the electrons. Accelerating voltages of 30-40 volts have mainly been used, and the light from the stream is observed at right angles to its direction. Under these conditions a number of p-d combinations are polarised, the plane of polarisation being with the maximum electric vector parallel to the stream. The plane of polarisation rotates with the tube and so cannot be governed by any stray field.

The following are the lines so far tried, the brackets indicating lack of separation:

Polarised.		Unpolarised.	
λ 5791 Å.U.	$\left\{\begin{matrix}2P-3D\\2P-3d_3\end{matrix}\right\}$	λ 5461 Å.U.	$2p_1-2s$
5770	$2P-3d_2$	4916	$2P-3S$?
$\left\{\begin{matrix}4347\\44\\39\end{matrix}\right.$	$\left.\begin{matrix}2P-4D\\2P-4d_2\\2P-4d_3\end{matrix}\right\}$	4358	$2p_2-2s$
		4108	$2P-4S$
$\left\{\begin{matrix}3906\\04\\02\end{matrix}\right.$	$\left.\begin{matrix}2P-5D\\2P-5d_2\\2P-5d_3\end{matrix}\right\}$?	4078	$2p_2-2S$
		4047	$2p_3-2s$
		3650	$2p_1-3d_1$
3663	$\left\{\begin{matrix}2p_1-3D\\2p_1-3d_2\end{matrix}\right\}$		
3655	$2p_1-3d_3$		

It is seen that the effects on combinations involving the various d and D levels are not completely disentangled, but that the results seem consistent with the view that the polarisation occurs in the case of combinations of the p or P levels with the D, d_2, and d_3 levels.

In the case of the yellow mercury lines 5770 and 5791, the effects can be investigated visually, using a filter. It has been found that the degree of polarisation decreases as the speed of the electrons is increased. At 20 volts the polarisation is about 20 per cent., but falls to less than 3 per cent. for an exciting voltage of 70 volts. Further, the polarisation of the light emitted directly from the path of the electrons can be distinguished from the smaller degree of polarisation of the light emitted from points outside the path of the stream. This seems to lead definitely to the conclusion that the polarisation is caused by the directed character of the electron stream.

The polarisation of the yellow lines is reduced to zero by a magnetic field of about 20 gauss at right angles to the stream and in the direction of observation, but a similar field parallel to the stream has no effect. The same field perpendicular to the stream and to the direction of observation reduces the amount of polarisation to roughly half its value. It remains to be seen whether balancing out the earth's field will bring to light any further effects.

The polarisation of the D lines of sodium excited by a directed stream of electrons has independently been investigated by Kossel and Gerthsen (*Ann. der Phys.*, 77, 273, 1925), but no effect was found; and just as this note was prepared, a paper of Ellett, Foote, and Mohler (*Phys. Rev.*, 27, 35, 1926) came to hand. Using a very low vapour pressure and exciting voltages only a little greater than the corresponding excitation potentials, they studied the cases of the sodium D lines, again with a negative result, and of the mercury line 2537, in which case they found a polarisation of 30 per cent. with the maximum electric vector *perpendicular* to the direction of the stream, that is, in a plane at right angles to that in which polarisation has been found in the case of the p-d combinations. As these authors point out, theoretically we should expect a polarisation with the maximum electric vector parallel to the stream, as is observed in the cases referred to in the present note. The decrease of the magnitude of the polarisation with increasing speed of the exciting electrons and the influence of the application of a magnetic field are also effects which may be interpreted theoretically.

H. W. B SKINNER.

Cavendish Laboratory,
Cambridge, February 8.

The Leaping Salmon.

WHEN Dr. Starr Jordan says "All salmon will leap over a waterfall where it is possible" (NATURE, January 16, p. 85) he surely refers to salmon in countries like America and Norway, where spring fish do not occur. In Britain salmon enter fresh water, in very many rivers, in every month of the year, and those which do so in the cold-water months—February, March, January, and April, to mention them in the order of coldness—do not leap at falls.

On arrival at the foot of a fall where there is much white water, even when the fall is only a few feet high, all farther ascent is stopped until the wintry thermal conditions have passed. In Scotland, this is usually about the third week in May

Another point to which, perhaps, I might venture to direct attention is the title of the illustration of the leaping salmon. This gives the impression that the particular fish shown is leaping a fall 30 feet high. This must mean that the falls of this Oregon river are really a series of cascades, since no salmon can leap anything like 30 feet. Provided there is a deep pool below the fall, from the bottom of which a fish can make a rapid upward swim, a salmon can leap about 8 to 9 feet vertical height. I have seen a sea-trout of apparently only about 2½ lb. do the same.

W L CALDERWOOD.

Edinburgh, March 1.

Re-Paging of Reprints.

I THINK every one will agree that one of the worst crimes of an author is to give wrong references. Will you kindly allow me to point out that a very frequent source of such errors arises from the re-paging of authors' separate copies? In my editorial work for the *Geological Magazine* I find many instances, and have learnt by experience always to mistrust and verify a reference giving page 1. It is easy to understand that foreign and colonial writers are specially likely to fall into this trap, as often they must rely on authors' reprints and have not a complete series of the periodical at hand.

The practice mentioned is very hard on both authors and editors, besides adding unnecessarily to the cost of reprints.

R. H. RASTALL.

Christ's College, Cambridge.

On One-Eyed Vision.

IN continuation of Sir Arthur Schuster's letter, February 28, p. 228, I feel sure that a person looking with one eye, when time enough is allowed for attention, substitutes for the doubleness of appearance utilised by two eyes a slight unconscious waggle of the head, and thereby secures the needed parallax.

Also I recall that once, glancing over back premises in London with one eye, I caught a glimpse of a cat walking on a near wall which looked surprisingly like a tiger on a far wall.

OLIVER LODGE.

Italy, February 19.

Peregrine Phillips, the Inventor of the Contact Process for Sulphuric Acid.

By Sir ERNEST COOK, D.Sc.

IT is unfortunately the usual fate of the inventor of a novel process of chemical manufacture to find that his monetary reward is little or nothing and that even his name soon ceases to be associated with the process. But probably in few instances is there so little known about the author of an important new method as in the case of Peregrine Phillips, the inventor of the 'Contact Process' for the manufacture of sulphuric acid. Possibly this is partly due to the long period that elapsed between the publication of the patent and the successful working of the process; and yet the broad details as practised to-day were described with fair accuracy in the application for protection originally asked for.

There can be little doubt that this method of manufacturing the acid is growing in importance every day—spacious and well-appointed works, erected at considerable cost, are either already started or soon will be, in Great Britain and other countries. The chamber method, which has served for so long a period, is gradually being superseded and will probably cease to exist as a commercial proposition in a few years' time.

This development has naturally directed attention to the personality of the original patentee. Who was he? Where did he live? What else did he do in the way of scientific discovery? In these respects we are figuratively up against a blank wall. Practically all that is known about him is contained in the specification of his patent; this states that ". . . PEREGRINE PHILLIPS, Junior, of Bristol, Vinegar Maker, send greeting."

The patent was applied for in 1831 and duly granted. It cannot be said that these particulars afford an extensive history of one who has given to the world the means of making an important advance in useful practical knowledge. This is regrettable, and in order to see if other details could be discovered I have made a search of such local records as could be consulted. The result, whilst not telling us much about the scientific career of the author, throws some light upon his business activity. Collecting the facts, the story is as follows.

Since the middle of the seventeenth century there have been several families of the name of Phillips amongst the inhabitants of Bristol, but no representative combining with that surname the Christian name of Peregrine appears until 1803. In that year a Peregrine Phillips opened a tailor's shop in Milk Street in that city. Here he continued to reside and work at his trade until 1831. I think we may consider that the business was fairly successful, because we find that in 1824 he was able to join one John Thorne in starting a business for the manufacture of vinegar at what must have been fairly large works at that time, at 48 Thomas Street. At the present time 48 Thomas Street is a part of the premises of a large hauliers' business, the buildings being of modern date. In 1824 the district was partly residential, with fairly large houses with several courtyards. Messrs. Phillips, Thorne and Co. adapted this house to their requirements and equipped it with suitable apparatus. Apparently this was done very successfully, because I find that vinegar-making was carried on here until 1865—a period of more than forty years. This venture also enabled him to find an opening for his son Peregrine, junior, who became the inventor of the sulphuric acid process. I think it may be taken as certain that Peregrine Phillips, jun., was born in Milk Street, Bristol, and was the son of the tailor, but I have quite failed to find any record amongst the local church registers (the only ones kept in those days), or the newspaper announcements in existence at the time, of the actual date of his birth. The similarity of name, and the association in business, leave little doubt of the relationship of father and son.

Whether the son took a hand in his father's business is doubtful, but judging by the wording and scope of the patent, I think we may conclude that he was well educated and possessed a considerable amount of sound scientific knowledge.

Nothing further is recorded about the firm until July 1831, when there appeared in the issue of *Felix Farley's Journal* for July 11, 1831, the following notice:

> Notice is hereby given that the Partnership between the undersigned PEREGRINE PHILLIPS, the elder, JOHN THORNE, and PEREGRINE PHILLIPS, the younger, of the City of Bristol, vinegar makers, was dissolved by mutual consent on the 13th day of June last, so far as respects the said PEREGRINE PHILLIPS, the younger.
>
> PEREGRINE PHILLIPS, Senior.
> JOHN THORNE.
> PEREGRINE PHILLIPS, Junior.
>
> *Witness*—Andrew Livett, Solicitor.
>
> The above business will in future be carried on under the firm of Phillips and Thorne by whom all the affairs of the above partnership will be settled.

This notice tells its own story. From it we can conclude that the business was not sufficiently prosperous to satisfy the ambitions of the three partners. But whether the dissolution of partnership was brought about by the dissatisfaction of the younger man with his prospects, or by the dissatisfaction of the older men with the attention to the business given by Peregrine, junior, we can only conjecture. In all probability both these considerations came into the problem.

The important patent which has given Peregrine Phillips, jun., a very high place amongst the comparatively short list of those inventors who have introduced a really new process of manufacture of an article of primary importance in all kinds of industries, was applied for in the early days of the year 1831. The licence was granted on March 21, the "particular description of the nature" of the invention made known on July 15, and the patent inrolled on September 14.

The patent is numbered 6096, A.D. 1831, and consists of two parts, in the first of which the inventor describes the plan he proposes for causing the combination of "sulphurous acid gas with the oxygen of the atmosphere" by making these gases pass through hot tubes containing finely divided platinum and other substances. In the second part he describes how he will obtain a more perfect condensation of the sulphuric acid when it is made. The whole document, obviously drawn up with the aid of those learned in the law, makes very interesting reading, and I venture to copy it in its entirety:

A.D. 1831 . . . . . *Patent No.* 6096.

Manufacture of Sulphuric Acid.

Phillips' Specification:

To all to whom these Presents shall come, I, Peregrine Phillips, Junior, of Bristol, Vinegar Maker, send greeting.

Whereas His present most Excellent Majesty King William the Fourth, by His Letters Patent under the Great Seal of Great Britain, bearing date at Westminster, the Twenty-first day of March, in the first year of His reign, did, for Himself, His heirs and successors, give and grant unto me, the said Peregrine Phillips, His special licence, sole privilege and authority, that I, the said Peregrine Phillips, my exors, admors, or assigns, or such others as I, the said Peregrine Phillips, my exors, admors, or assigns, should at any time agree with, and no others, from time to time and at all times during the term of years therein mentioned, should and lawfully might make, use, exercise, and vend, within England, Wales and the Town of Berwick-upon-Tweed, my Invention of "Certain Improvements in Manufacturing Sulphuric Acid commonly called Oil of Vitriol"; in which said Letters Patent is contained a proviso that I, the said Peregrine Phillips, shall cause a particular description of the nature of my said Invention, and in what manner the same is to be performed, to be inrolled in His said Majesty's High Court of Chancery within six calendar months next and immediately after the date of the said in part recited Letters Patent, as in and by the same, reference being hereunto had, will more fully and at large appear.

Now know ye, that in compliance with the said proviso, I, the said Peregrine Phillips, junior, do hereby declare that the nature of my said improvements are herein set forth and explained; but for the better understanding of the subject I shall first describe the present mode of manufacturing sulphuric acid, next, the improvement I propose to effect, and then the means by which those improvements are effected.

Sulphuric acid or oil of vitriol is generally manufactured at present by the combustion of sulphur or brimstone and saltpetre, either mixed together and placed in large leaded chambers or separately in ovens connected with these chambers, into which chambers more or less of atmospheric air is admitted. The sulphur at first is converted by the combustion into sulphurous acid gas, and then by the agency of nitrous gas united with oxygen from the atmospheric air in the chamber or from that liberated from the saltpetre, and is thus converted gradually into sulphuric acid, and is afterwards absorbed by the water which covers the bottom of the chamber.

The first improvement, then, which I propose to effect is, an instantaneous union of the sulphurous acid gas with the oxygen of the atmosphere, and thereby save the constant expense of saltpetre, and also the great outlay of capital in the chambers where any great quantity of sulphuric acid can be manufactured by the gradual conversion of the sulphurous acid into the sulphuric acid.

The second improvement I propose to effect is, to effect a more perfect condensation of sulphuric acid when made by an improved mode of absorbing the same. The first improvement then, namely, the instantaneous union of sulphurous acid with the oxygen of the atmosphere, I effect by drawing them in proper proportions by the action of an air pump or other mechanical means through an ignited tube or tubes of platina, porcelain, or any other material not acted on when heated by the sulphurous acid gas. In the said tubes or tube I place fine platina wire or platina in any finely-divided state, and I heat them to a strong yellow heat, and by preference in the chamber of a reverberatory furnace; and I do affirm that sulphurous gas being made to pass with a sufficient supply of atmospheric air through tubes as described, properly heated and managed, will be instantly converted into sulphuric acid gas, which will be rapidly absorbed as soon as it comes in contact with water. The sulphurous acid gas I cause to be generated by the combustion of sulphur or pyrites, or any other metallic sulphuret, in a close oven, having one or more apertures for the admission of atmospheric air, and another aperture leading to or communicating with the aforesaid tubes. The relative proportions of sulphurous gas and atmospheric air are regulated by the size and working of the air pump, which must pump out at least eighty-five cubic feet of air for every pound avoirdupois of sulphur consumed.

My second improvement, namely, a more perfect condensation of the sulphuric acid when made, I effect thus:—I cause a chamber or chambers to be erected, of any size and materials that may be thought convenient, but by preference of silicious stone in a circular form, and about eight feet in diameter and thirty feet high. This I cause to be lined nearly or throughout with lead, to be filled nearly to the top with silicious pebbles, or any substance presenting an extensive surface, and not acted upon by the sulphuric acid. Upon the pebbles or other substances I place a sheet of lead, pierced with small holes, for the better distribution of the liquor to be hereafter mentioned. The chamber is to be domed over, and rendered air-tight on the outside, except by an opening on the top, through which a quantity of water or dilute acid is let in upon the pebbles to the height of about fourteen inches. A lead pump is fixed by the side of this chamber, drawing the liquor from its bottom, and emptying its contents into a lead funnel placed in and over the aforesaid opening in the top of the dome, and which said pump is kept constantly worked by a steam engine or any other power that may be preferred. The pipe of the funnel must be of such a size as always to keep some liquor in the funnel, and never to allow any air to pass down that way into the chamber; and the pump must throw a sufficient quantity of liquor to keep all or the greater part of the pebbles moistened. A pipe leading from the ignited tube or tubes, after passing through some water for the purpose of cooling it, terminates in this chamber just above the top of the liquor, while another pipe going off from the top of the chamber leads to the air pump, so that all the air charged with sulphuric acid has to pass through the bed of moistened pebbles, which have a constant supply of water or dilute acid continually passing down them. When the liquor is considered sufficiently charged, or when it will not absorb the sulphuric acid gas, which may be known by examining, the air discharged from the air pump is to be drawn off by a pipe and cock in the bottom of the chamber, and treated in the usual way.

Note, I do not claim a right to any mode by which sulphur or sulphurets may be converted directly into sulphuric acid by the action of heat or otherwise, if such method ever has been or ever shall be discovered; but I claim an exclusive right to any plan by which sulphurous gas and atmospheric air, either alone or mixed with any other gas or gases, shall be either forced or drawn by an air pump or any other mechanical means through an ignited tube or tubes.

I also claim the exclusive right to the use of platina in any finely-divided state, for the purpose of assisting the action of heat in combining sulphurous gas with oxygen in the manufacture of sulphuric acid.

I likewise claim an exclusive right to every mode by which chambers used in the manufacture of sulphuric acid can be charged with silicious pebbles or other substances for the purpose of exposing extensive surfaces, and which surfaces can be either constantly or occasionally moistened by the liquor pumped or drawn from below them.

IN WITNESS WHEREOF, I, the said PEREGRINE PHILLIPS, have hereunto set my hand and seal, this Fifteenth day of July, in the year of our Lord One thousand eight hundred and thirty-one.
PEREGRINE (L.S.) PHILLIPS, Junr.

Signed, sealed and delivered in the presence of
JAMES LIVETT, Solr., Bristol.
RICHD. HOWELL, His Clerk.

AND BE IT REMEMBERED that on the Fifteenth day of July, in the year of our Lord, 1831, the aforesaid Peregrine Phillips came before our said Lord the King in His Chancery, and acknowledged the Specification aforesaid, and all and every thing therein contained and specified, in form above written. And also the Specification aforesaid was stamped according to the tenor of the Statute made for that purpose.

Inrolled the Fourteenth day of September, in the year of our Lord One thousand eight hundred and thirty-one.

When we remember the time, and the absence of institutions for acquiring scientific knowledge, I think we may conclude that the author of the process had acquired a considerable amount of accurate information which he was able to apply to practical use. Moreover, this invention was no lucky or momentary inspiration. The knowledge displayed could only have been acquired by steady and continuous work.

Peregrine Phillips, jun., was a young man who had made good use of his youth in acquiring valuable knowledge. It is noteworthy that although nearly a hundred years have elapsed since this young Bristolian made his experiments and gradually improved his apparatus, yet the essential details are the same to-day as they were when first made known.

The necessary protection having been obtained by the grant of the patent, the next point to inquire about is as to the author's success in working the process. But here my records absolutely fail me. Both directories and newspapers give no information. We may therefore conclude that no works for making sulphuric acid by this process were established in Bristol. Moreover, the name of Peregrine Phillips, jun., disappears from every local record after 1831, and his late private residence is occupied by another. In all probability this means that directly after the dissolution of partnership in June, he left Bristol to seek his fortune elsewhere.

Possibly in that elsewhere he tried to work his invention, but probably without commercial success. This is not to be wondered at when we remember the large amount of plant employed in modern works using the method.

In these works engineering skill and chemical knowledge, which were not even thought of in 1831, are made to assist, and the combined results are highly satisfactory. But the poor inventor had none of these things, and his reward was probably nil. It was not until nearly fifty years after that the Badische Anilin und Soda Fabrik successfully worked the process on the large scale in Germany.

The youngest partner having left the vinegar business, its subsequent history is soon told. In the notice of dissolution quoted above it is stated that the business will in future be carried on under the name of Phillips and Thorne. But it did not last long. In 1831 the elder Phillips gave up his business of tailor and went to live at the vinegar works in Thomas Street. But in 1832 the works were abandoned. No notice of any bankruptcy can be traced, so we may conclude that trade had gradually declined so much that it was not worth while carrying on any longer.

In the *Bristol Journal* for October 5, 1832, appears the notice of a sale by auction on the premises, 48 Thomas Street, of the "entire vinegar plant, stock in trade, complete apparatus, &c. &c.," of the "late firm of Phillips and Thorne, they having dissolved partnership." Full details are given, and it is obvious that the works were fairly extensive and well equipped.

Immediately after this the father seems to have left Bristol, for no other record later than the date of this sale can be found. The name of Peregrine Phillips, either senior or junior, entirely disappears from Bristol records. Parish registers, as well as the official records, have been searched, but no notice of the deaths of either of our worthies can be discovered. Undoubtedly they left Bristol finally in 1832.

The discovery of Peregrine Phillips, jun., was undoubtedly of first-rate importance, and the young man must have been of far more than ordinary intelligence; yet it is quite easy, if not probable, that the history recorded above reveals a note of tragedy. As thus: Peregrine the elder was probably an industrious and prosperous tradesman, and was making a good income. He was blest with a clever son whose future was dear to him. Money was freely spent on his son's education, and when he became of age the savings of his father were used to start him in a business of far greater possibilities than that in which his father had done so well. So great was the father's confidence in his son's ability that he left the conduct of the business to him and his partner whilst he himself continued to work at his trade in Milk Street. But the genius of the son was not suited to the humdrum of business details. He was experimenting on bigger things than vinegar making, and as a result of his work he introduced the process which has benefited succeeding generations but not himself. The result was inevitable. The business did not pay and a rupture ensued. The son left, and the old father, in order to save his money which he had invested in the business, gave up his tailoring to try to save his capital; but without much success. Possibly the old man, having lost most of his money, left the city where he had held an honourable position for so many years.

Seasonal Sunshine in Great Britain.

By Chas. Harding.

NEVER before has the good effect of sunshine on health been so fully recognised as it is now; the great benefit derived from sunshine by individuals of all ages, whether strong and robust, or weak and delicate, is being brought home to us in many ways. The records of sunshine by Campbell-Stokes' self-registering instruments are very satisfactory so far as registration is concerned, but compared with other meteorological elements such as pressure, temperature, and rainfall, they are of more recent date. Sunshine records were practically commenced in about 1881, but by ordinary observers they have been somewhat tardily used.

The "Book of Normals" published by the Meteorological Office, giving monthly normals for stations for the 35 years from 1881 to 1915, supplies the principal facts for comparisons here made. These on examination are found to contain comparatively few complete records for the 35 years; the majority of the stations are for shorter periods and are worked up to the 35-year period by comparison with adjacent stations. For the most part, only those stations are taken which have observations of sunshine for the complete period, so that the comparisons are more trustworthy than they would otherwise be.

Dealing first with the annual results, and comparing the records for the year in different parts of Great Britain, it is found that in Scotland there are five stations which yield an average annual duration of sunshine amounting to 3·41 hours a day; the most is 3·80 hours a day at Aberdeen; the least, 2·97 hours a day at Glasgow. In the south of England, taking Southampton, Falmouth, and Plymouth, the average annual duration is 4·65 hours a day, ranging from 4·56 hours at Plymouth to 4·82 hours at Falmouth. The excess in the south of England over Scotland amounts, on the average, to 1·24 hours a day for the year.

Comparing eastern and western districts, the stations in the eastern districts of England give an annual duration of 4·19 hours a day, while the western stations give 4·17 hours a day.

The central or Midland counties give an annual average duration of 3·90 hours a day—two of the three stations taken are Oxford and Cirencester, which give 4·13 hours a day, the agreement for the year and for the several seasons being remarkably similar.

Dealing with quarterly results of sunshine, dividing the year as generally recognised in meteorology, the winter quarter being represented by December, January, and February, and the summer quarter by June, July, and August. In the north of Scotland, as shown by the Orkneys and the Hebrides, there is little difference between the spring and summer sunshine; indeed, in the Orkneys the duration of sunshine is rather greater in the spring, the relative amounts being 4·60 hours a day in spring and 4·54 hours a day in the summer. For Scotland as a whole the average daily sunshine for the four quarters, starting with winter, is 1·34, 4·64, 5·02, and 2·60 hours; for the south of England the corresponding seasonal values are 2·08 hours a day, 5·78, 6·94, and 3·78 hours. The greatest gain for any season in the south of England is 1·92 hours a day in the summer season, and the least gain is 0·74 hours a day in the winter.

In the east of England the seasonal daily values are 1·85 hours in the winter, and in the following seasons 5·23, 6·26, and 3·40 hours; in the western district of England the corresponding values are 1·68 hours a day in the winter, followed in the other seasons by 5·46, 6·26, and 3·25 hours. The average daily duration of sunshine is thus less in the winter and autumn in the western district, including St. Ann's Head and Douglas in the Isle of Man, than in the eastern, absolutely the same in summer in both districts, but more in the western district in the spring.

In the central or Midland counties the seasonal sunshine records give for the winter 1·68 hours a day, and for the following seasons 4·88, 5·87, and 3·13 hours; these are less than for the east of England in all seasons, and are less than in the western districts except for the winter, when the two districts are in absolute agreement.

A later "Book of Normals" published by the Meteorological Office gives the weekly, monthly, quarterly, and seasonal normals for districts for periods ending with 1915. In all seasons the least sunshine occurs in the north of Scotland and the most in the English Channel. Comparing south-east England with south-west England and South Wales, the average sunshine for the year in south-east England is 4·49 hours a day, and in south-west England and south Wales, including the so-called Cornish Riviera, it is 4·28 hours. In the winter, south-east England has an average daily sunshine of 1·92 hours, and in south-west England and south Wales the value is 1·91 hours a day; in spring the hours of sunshine for the two districts are respectively 5·50 and 5·36; in summer 6·88 and 6·41, and in autumn 3·46 and 3·31 hours. In each season, therefore, the value for the eastern district is above that of the western.

The amounts of sunshine vary considerably in different years and in different seasons. A record of 40 years' sunshine at Oxford, from 1881-1920, shows that the highest total in any year is 1810 hours in 1899, and the least, 1158 hours in 1888. In the winter months the amounts range from 106 hours in February 1899 to 5 hours in December 1890; in spring from 294 hours in May 1909 to 62 hours in March 1916; in summer from 310 hours in July 1911 to 99 hours in July 1913; in autumn from 223 hours in September 1911 to 30 hours in November 1888.

For the corresponding 40 years at Greenwich Observatory the maximum hours of sunshine in any year is 1778 in 1911, and the least in any year is 1069 hours in 1888. The year 1921 had sunshine for 1761 hours, but this is after the 40-year period. In the years 1892–96 the records at Greenwich are doubtful, owing to the development of cloudiness in the glass sphere of the sunshine recorder, the glass having deteriorated; this suggests the need of great care at other stations at home and abroad. In the winter months the amounts range from 106 hours in February 1914 to 2 hours in December 1890; in spring from 326 hours in May 1909 to 46 hours in March 1888; in summer from 335 hours in July 1911 to 95 hours in August 1913; in autumn from 234 hours in September 1911 to 23 hours in November 1912.

In the abnormal summer of 1911, in the 18 weeks from the commencement of June to the end of September, there were 15 weeks with an excess of sunshine in England E., Midland Counties, England S.E., and England S.W.; 14 weeks in England N.E. and N.W.; 13 weeks in Scotland W. and in the English Channel. July was exceptionally bright; in the south of England the excess of sunshine was very great, averaging about 5 hours a day more than usual at some stations. Eastbourne and Hastings had 160 per cent. of the average; Greenwich and Kew Observatory, 161; Brighton, 163; Plymouth, 169; Torquay, 172; and Tunbridge Wells, 180 per cent. At Greenwich the duration was 335 hours, which is 110 hours more than the average; this was the brightest July since the commencement of sunshine records. The duration of bright sunshine at Greenwich for the four months June to September was 1053 hours, a higher total than in any previous year on record. In 1911 the duration of sunshine at Greenwich was 1778 hours; at Westminster, 1592 hours; and at Bunhill Row, in the heart of the City, 1444 hours, showing clearly the loss of sunshine in the metropolis; the loss is usually proportionately greater in the winter than in the summer. The duration of sunshine at Greenwich for the summer season June to August in 1911 was 819 hours, and the mean temperature for the three months was 66°·1, about 5° in excess of the normal.

The following shows the difference between a good and bad season for sunshine: The year 1903 was about the wettest year on record, certainly the wettest at Greenwich Observatory for the last hundred years. The summer rainfall at Greenwich, June to August, was 16·16 inches, and the duration of bright sunshine 560 hours; whereas in 1911 the duration of bright sunshine was 819 hours. Last year, 1925, was a dull and comparatively sunless summer; the total duration of sunshine in the three summer months was 587 hours, and the total rainfall was 6·10 inches. The year 1924 also had a dull summer; the total sunshine at Greenwich was 589 hours, and the rainfall was 8·49 inches. These summers were remarkably dull in comparison with 1911 and 1921.

However desirable it may seem to decide which part of England enjoys the longest duration of sunshine, it is not easy to determine the most sunny region, although the following results seem to give a preference to south-east England. The published records of the Meteorological Office available for 35 years, which enable a trustworthy comparison to be made, give results for fewer stations than seem desirable, and in years to come, as the periods increase, results will become more satisfactory.

The highest average annual duration of sunshine at any station for the period of 35 years, 1881 to 1915, is 4·92 hours a day at St. Leonards, in England S.E.; and the station with the next highest average annual duration is Falmouth, in the Cornish Riviera, with 4·82 hours a day. The seasonal values for the two stations are: St. Leonards in the winter 2·25 hours a day, and in the following seasons 6·01, 7·34, and 4·03 hours; at Falmouth in the winter 2·21 hours a day, and in the following seasons 6·01, 7·15, and 3·90 hours; St. Leonards having most sunshine at all seasons except in the spring, when the duration of bright sunshine is the same in both places.

Records for less than 35 years given in the Meteorological Office normals show that, after weighting with other stations near, Felixstowe in England E., with 11 years' observations, ranks highest for the year, with 5·04 hours a day, and with a summer average of 7·84 hours a day. Worthing, with 17 years' observations, has an annual average of 4·98 hours a day and a summer average of 7·42 hours a day. Eastbourne, with observations for 30 years, has an average annual duration of 4·88 hours a day and a summer average of 7·37 hours. All of these have a higher daily average sunshine than the Cornish Riviera.

A rough summary of sunshine observations such as that here given is far from satisfactory, and is drawn up for the most part on published data readily to hand. Without doubt there are many considerations of greater importance to the Meteorological Office and to the general public, but since there has been a great accumulation of sunshine observations over Great Britain in recent years, an official discussion bringing the normals up-to-date would be of considerable scientific interest and would, without doubt, be heartily welcomed.

News and Views.

General approval from scientific men and naturalists the world over will be extended to the Society for the Preservation of the Fauna of the Empire in its active propaganda against the indiscriminate and wholesale destruction of wild game as a means for the extermination of tsetse flies, and, therefore, of the diseases, both of human beings and stock, which they are the means of transmitting. Certain proposals to throw open game reserves in Zululand led to a deputation from the Society, headed by Dr. P. Chalmers Mitchell, to the High Commissioner for the Union of South Africa, to protest against this measure, and a report of its proceedings, together with a memorandum on the subject, printed in the December number of the Society's journal, will be read with great interest and sympathy. The Society urges that the indiscriminate slaughter of big game does not necessarily lead to the extermination of the tsetse-flies, but may have the result of leading the flies to seek other and smaller hosts, still more difficult to control, or failing a suitable wild host, to attack man himself The danger to the human population would, therefore, be increased rather than decreased, and, in the Mwanza district of the Tanganyika Territory, where wholesale game destruction due to military operations was followed by a serious epidemic of sleeping sickness, there would appear to be evidence in support of this view. The Society urges strongly a more scientific approach to the solution of the problem by detailed studies of each separate species of fly and host, and a painstaking survey of local conditions before any measures are adopted. It points to the success which has been achieved in Tanganyika Territory by systematic attack on the important bush elements by the native population and by organised late grass-burning as measures for controlling the breeding-places of the flies, and pleads for further trial of such methods in Zululand. It agrees that discriminate control of wild game would probably help in the final solution of the problem.

MR. SAMUEL AUGUSTINE COURTAULD has given 30,000*l.* to the Middlesex Hospital Medical School, London, to found an Institute of Biochemistry. The new building will be in the precincts of the Hospital, and will probably consist of seven storeys, the upper five of which will be devoted to all branches of biochemistry. The Hospital has endeavoured to develop the study of this subject during the past years, with the result that the size of the work has outgrown the existing accommodation. At the present time chemical physiology, chemical pathology, and the chemical routine work for the Hospital patients, together with the more purely chemical investigations of natural products, are dealt with in the same department. This has necessitated the acquiring of a series of scattered laboratories and of occupying rooms in the Bland-Sutton Institute of Pathology.

MR. COURTAULD's gift will enable the Middlesex Hospital to constitute a compact department of much greater size, in which all the above-mentioned branches of study can be pursued. Workers in the new institute, however, will still retain the privilege of close co-operation with the Bland-Sutton Institute of Pathology, and with the clinical staff of the Hospital, and thus the new institute will be in rather a unique position. The constant passage of routine work through such a department will focus the attention upon the clinical and therapeutic aspect of biochemistry. Although the plans of the new department, which will be called the S. A. Courtauld Institute of Biochemistry, have not yet been definitely decided upon, it is proposed to make ample provision for the teaching of both chemical physiology and chemical pathology. A large laboratory for the more organic chemical side of the work will be included, together with accommodation for the pharmacological testing of chemo-therapeutic substances. Mr. Courtauld's very generous gift will enable the Hospital to continue its support of this very valuable line of teaching and research.

A RECENT announcement made in the Legislative Assembly at Delhi by Mr. J. W. Bhore, the Secretary of the Department of Education, Health and Lands, is of considerable interest since it brings to an end a period of uncertainty as to the future position both of research and education in forestry in India. It will be remembered that the Forest Research Institute at Dehra Dun was inaugurated in 1906, the Forest School being given the status of a College. A two-year course for the training of the Provincial Service was afterwards instituted, the courses previously given being for the subordinate staff only. In 1914 the Research Institute building was opened. The War made considerable demands upon the Institute, and the research work carried out there, especially in utilisation, was of material importance to the country. By 1919 it was apparent that the research work had already outgrown the block of buildings erected in 1914. The value of this work was fully appreciated by the Government of India, and a scheme was drawn up for the erection of a new Research Institute on a far larger scale, land being acquired for the purpose. A check was given to the development of the new scheme owing to the recommendations of the Inchcape Retrenchment Committee. The Institute was placed on a block grant for three years. Mr. Bhore now announces that the Government of India has sanctioned the whole grant for the new buildings. He also states that the training of the Indian probationers for the Imperial Forest Service will in future be undertaken at Dehra Dun; a two-year diploma course will be given there, the old Research Institute building of 1914 being converted for this purpose. It is perhaps a little sanguine to hope that the training at Dehra will be as good as that given at the universities of Great Britain, but the experiment will be watched with interest.

SIR FREDERICK GOWLAND HOPKINS presided on March 13 over a dinner of the Biochemical Society held at the Grosvenor Hotel, London, to celebrate the hundredth meeting of the Society. In proposing "The Society" he traced the change of opinion concerning bio-chemistry, which has taken place since he went to Cambridge thirty years ago, and was informed that bio-chemistry was not biology and certainly not chemistry. After paying a tribute to Mr. J. A. Gardner and Prof. R. H. A. Plimmer in inaugurating the Society, he directed attention to its constantly accelerating progress, remarking that only one plateau has appeared in the curve of membership, and that was during the years 1914–18. Biochemists, he said, are highly privileged persons, because many of them are brought into close contact with agriculture and other vitally important industries. They need, however, encyclopedic knowledge, because they never know from what source they may derive information of vital importance. Describing the genesis of the Society, Mr. Gardner explained his indignation one morning in 1911 on learning in the daily press that an Austrian was to be sent over to England to teach British workers how to apply chemistry to living tissues. In response to post-cards sent out by Prof. Plimmer and himself, thirty-two bio-chemists attended a meeting and the Society was founded Prof. Harden spoke of the keenness of members; in the Chemical Society, he said, there is one paper to every ten members, but in the Biochemical Society there is one paper to every three members. Prof. E. H. Starling proposed the health of Sir Frederick Hopkins. Characterising him as the leader of the school of British bio-chemistry, he said that he differs from most workers in being a natural historian as well as a trained chemist. In his work there is no such thing as an unconsidered trifle. He referred also to the bearing that his appreciation of colour has had on his researches.

THE Bureau of Chemical Abstracts, which now issues the *British Chemical Abstracts* for the Chemical Society and the Society of Chemical Industry, is endeavouring to secure uniformity in the method of referring to original papers. It issues to its abstractors a pamphlet of instructions as to what information the abstracts should contain, the use of the terminations *ous* and *ic*, the distinction between hydroxides and hydrates, and the restriction of *ol* to alcohols, the other *ols* to become *oles*. A list of recognised abbreviations and symbols is also given. Of the great need of more uniformity in the nomenclature and notation of chemistry there can be no doubt, and in these matters the views of the Bureau will have great weight, but on questions common to all sciences the views of other bodies publishing abstracts at home and abroad must be considered. The Chemical Bureau advocates the order: title, author, journal, year, volume, page in abstracts or references, while the more common practice is to give the year last. For dates it uses (p. 4) '25.6.23,' but does not indicate whether the year is the first or the last number given, and astronomers would understand 1925.6.23. Although the method of writing the time of an event is not one of the points dealt with in the instructions, and one might write 5.30 P.M. June 23, 1925, without being considered unmethodical, the astronomer's logical 1925, June 23, 17h. 30m. has much in its favour.

NEAR Quetta in British Baluchistan, Dr. C. G. Abbot, assistant secretary of the Smithsonian Institution of Washington, D.C., and Director of the Smithsonian Astrophysical Observatory, has found the most suitable site that he has seen thus far in his search of the eastern hemisphere for a place to locate a new solar observation station. This new station, to be erected by the Smithsonian Institution with funds provided by the National Geographic Society, will be the third under the direction of the Smithsonian Institution making daily observations of the variable radiation of the sun, the other two being located in Chile and California. This third station will furnish a needed check on the values from the other two, providing a more dependable daily value of the solar constant. It is hoped that accurate long-range weather forecasting may become possible as a result of this fundamental work by the Smithsonian Institution. Dr Abbot has visited the Sahara and India and now is on his way to south-western Africa.

IN his discourse at the Royal Institution on Friday evening, March 12, Sir J. J. Thomson, Master of Trinity College, Cambridge, observed that the brilliance of the electric discharge has long been known, and exemplified in its greatest brilliancy in lightning and the aurora; but the subject of his lecture was confined to the radiation from electric discharges through gases in tubes of various forms. The radiation from Röntgen rays and other kinds of radiation inside tubes cannot get out. Evidence of the existence of radiation in these tubes can be obtained by means of the luminescence discovered by Wiedeman; it can be located by shadows, or its effects shown by ionisation (Hoffmann). The radiation from electric discharges can be observed and measured by the use of films of various substances inside the tube, showing the photo-electric effect. By using aluminium and celluloid screens with the tube, the absorption of radiation can be shown. The stream of negative and positive particles can readily be demonstrated by reversing the current. There were elaborate experiments shown during the course of the lecture by means of alternating currents and the use of reflectors within the tubes: in one case a magnificent ring of light appeared in the tube.

THE Department of Scientific and Industrial Research has recently established a small research laboratory in the vicinity of Covent Garden fruit and vegetable market. The laboratory will work in close connexion with the Low Temperature Research Station, Cambridge, which is the headquarters of the fruit and vegetables section of the Department's organisation for food investigation. Problems which are beyond the resources of the laboratory can therefore be handed on to the Station without delay. The object of the laboratory is to bring the Low Temperature Research Station into closer contact with the trade in fruit and vegetables, and with the practical aspects of the problems of their transport and storage. Covent Garden has been selected as the most suitable situation for the Laboratory because fruit and vegetables can be studied there at all times of the year; because its supplies are derived from all quarters; and because it is a convenient centre from which to reach the main producing areas in England, and the chief ports to which supplies are brought from overseas. The address of the Laboratory is: The Covent Garden Laboratory, Dudley House, Endell Street, London, W.C.2.

THE December issue of *Isis* contains the seventeenth Critical Bibliography of the History and Philosophy of Science and of the History of Civilisation. The original conception of this extremely useful annual bibliography was due to Dr. George Sarton, who continues to edit it, although the journal *Isis* itself is now published by the History of Science Society. In the present bibliography there are no less than 482 items, a fact which speaks well for the progress of what the Bishop of Birmingham recently referred to as the new humanism. The entries are systematically arranged, so that scholars interested in a particular subject or period can gather the information they require with very little trouble. The more important items are provided with short descriptive notices, generally from the pen of the editor himself, but occasionally written by experts on the subject under consideration. Of all the features of *Isis*, we regard these critical bibliographies as among the most valuable; they are, indeed, unique and indispensable. The useful bibliography given by Prof. Aldo Mieli in the *Archivio di Storia della Scienza* deals practically entirely with Italian work, while the *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften* does not cast its net nearly so widely as the indefatigable Dr. Sarton. Readers of NATURE who wish to support the invaluable work which *Isis* is doing should write to Dr. Frederick E. Brasch, secretary of the History of Science Society, Smithsonian Division, Library of Congress, Washington, D.C., U.S.A.

A PAMPHLET of nineteen pages from the Geological Survey of China includes a useful summary of the progress of the Survey under four heads, namely: (1) Ten years' work of the National Geological Survey of China; (2) Provisional programme of "Palæontologia Sinica"; (3) Memorandum on the establishment of museums in Peking; (4) Memorandum on the extension and rebuilding of the Geological Museum. The first section includes an index map showing the areas of China which have been geologically surveyed and of which a geological map on the scale of 1 : 1,000,000 has been prepared; the first sheet has been issued, and four others are in the press. The Survey Library was mainly established at the cost of 40,000 dollars subscribed by the mining companies and private donors. The Geological Survey was allotted in 1916 an annual grant of 80,000 dollars, but the amount received has fallen to 20,000 dollars, and the work has been carried on through the self-sacrifice of the members of the Survey. The list of the Survey publications shows an output of work which is highly creditable in consideration of the political and financial embarrassments of the past few years. A memorandum by Dr. Gunnar Andersson announces the proposed establishment of a Biological Museum at Peking of the same standard as the Geological Museum; the ideal is a group of museums, each organised as an institute for scientific research combined with an educational exhibition.

THE weather in the British Isles for the winter season ending February 27 is dealt with in the *Weekly Weather Report*, published by the Meteorological Office from observations during the months of December, January, and February. District values and their deviations from the normals are given for eleven districts of the British Isles, together with the mean values for the whole. Mean temperature was highest in the Channel Islands, where it was 46°·2 F., and lowest in the east of Scotland, where the mean was 37°·5; in the south-east of England, including London, the mean was 41°·7. Mean temperature for the winter was above the normal in all districts except in the east of Scotland, where the deficiency was 0°·1. The greatest excess over the normal was 1°·4 in the north of Ireland, and the next highest excesses were 1°·3 in the south-east of England and 1°·2 in the east of England. The absolutely highest temperature was 60° in the north-east of England, varying to 55° in the west of Scotland; the lowest was 4° in the east of England, ranging to 18° in the south of Ireland and 28° in the Channel Islands. Rainy days were in excess of the normal in all districts; the greatest excess was 10 days in the east of Scotland. The aggregate amount of rain was in excess in all districts except in the north of Scotland, where the deficiency was 1·77 in., the greatest excess was 3·78 in. in the Channel Islands, while in the south-east of England the excess was 2·25 in. There was a slight deficiency of sunshine in all districts except in the south-east of England, where there was an excess of 0·1 hour a day on the normal, and the average duration of sunshine, which for the winter was 1·9 hours a day, was greater than in any other district except the Channel Islands, where it was 2·1 hours a day.

THE recently issued part of *Curtis's Botanical Magazine* (Part ii. of Vol. 151) contains eleven plates, most of them "L. Snelling del et lith," which worthily maintain the high standard appropriate to the present editor, Dr. O. Stapf. In the *Journal of the Royal Horticultural Society*, Vol. 51, Part i., January 1926, Dr. Stapf has a very vivid and forceful account of the history of this famous magazine, commenced in 1787 by William Curtis, as an illustrated magazine, to issue to subscribers to his garden at Lambeth Marsh and other interested patrons, and incidentally to retrieve his financial losses upon a monumental and far too expensive "Flora Londinensis." Dr. Stapf traces the history of the magazine through its various vicissitudes, its triumphal career under the Hookers, father and son, its association with Kew when Sir William Hooker became Director of the Royal Botanic Garden, and its submergence during the difficult years following the War. This history is a timely reminder to the fellows of the Royal Horticultural Society of the fine tradition of this magazine and the purpose it serves, as it is now edited by Dr. Stapf for the Society, which has undertaken responsibility for the new issue, and in so doing promoted the interests both of botany and horticulture. Incidentally the current issue illustrates by the proverbial exception the general rule as to its contents. The magazine illustrates, not native plants, but plants introduced to British gardens from all parts of the world, the illustrations being accompanied by authoritative and very valuable systematic descriptions, with notes on the distribution of the plant and its cultivation in Great Britain. In the present number, however, appears a British plant, *Aconitum anglicum*, Stapf, a new species which the editor creates for a monkshood often grown in English gardens, but also found wild in England. Dr. Stapf has failed to trace it outside England and is forced to the conclusion that it is truly native.

WE much regret to announce the death, on March 15, at the age of seventy-nine years, of Sir Philip Watts, K.C.B., F.R.S., lately Director of Naval Construction, Admiralty.

THE seventh Mackenzie Davidson Memorial Lecture of the Röntgen Society will be delivered by Dr. A. Dauvillier of Paris. Particulars of the subject and date will be given later.

SIR ARTHUR SMITH WOODWARD has left England for Beirut, Syria, where he will be engaged for the next three months in the preparation of a work on the Cretaceous fishes of Mount Lebanon.

AT the meeting of British botanists held in the rooms of the Linnean Society of London on March 10, it was resolved to send an invitation to the members of the fourth International Botanical Congress (Congress of Plant Sciences) meeting at Ithaca, New York, U.S.A., in August, 1926, to meet for the fifth International Botanical Congress, in London, in 1930.

THE Council of the British Association will nominate Sir Arthur Keith, Hunterian professor in the Royal College of Surgeons and secretary of the Royal Institution, as president of the Association for the meeting in Leeds in 1927. The presidency of Section K (Botany) at the Oxford meeting, made vacant by the death of Dr. William Bateson, will be filled by Prof F. O. Bower, formerly Regius professor of botany in the University of Glasgow.

THE New Museums Club, an association of University employees at Cambridge, is organising a popular scientific exhibition to be held in the University Examination Hall and the new wing of the Chemical Laboratory on March 24-27. The entire proceeds are to be given to the benevolent fund of the University Servants' Pension Scheme. The exhibition will be arranged with the view of giving a popular idea of the teaching of science and the scope of research in the University, and three lectures are to be given each day by different members of the University staff, including the vice-chancellor, Prof. A. C. Seward, who will describe " A Trip to Australia."

AT the annual general meeting of the Ray Society held on March 11, the following officers were re-elected: *President*, Prof. W. C. McIntosh; *Treasurer*, Sir Sidney F. Harmer; *Secretary*, Dr. W. T. Calman. Mr. C. D. Soar was elected a vice-president, and Mr. J. M. Offord and Mr. E. Whitley were elected new members of council It was announced that Prof. von Goebel's "Wilhelm Hofmeister: the Work and Life of a Nineteenth Century Botanist," translated by Mr. H. M. Bower and edited by Prof. F. O. Bower, would shortly be published, and that the Society's issue for 1926 would be the second volume of " British Hydracarina," by Mr. C. D. Soar and Mr. W. Williamson.

THE following have been elected officers of the Physical Society for the year 1926–27: *President*, Prof. O. W. Richardson; *Vice-Presidents*, Sir Oliver Lodge, Sir Richard Glazebrook, Dr. C. Chree, Prof. H. L. Callendar, Sir Arthur Schuster, Sir J. J. Thomson, Mr. C. Vernon Boys, Prof. C. H. Lees, Sir William Bragg, Dr. Alexander Russell, Mr. F. E. Smith, Dr. E. H. Rayner, Dr. J. H. Vincent, Dr. D. Owen, Prof. F. L. Hopwood; *Secretaries*, Prof. A. O. Rankine, Imperial College of Science and Technology, Mr. J. Guild, National Physical Laboratory, Teddington, Middlesex; *Foreign Secretary*, Sir Arthur Schuster; *Treasurer*, Mr. R. S. Whipple, 45 Grosvenor Place, S.W.1; *Librarian*, Mr. J. H. Brinkworth. Prof. Charles Fabry, professor of physics at the Sorbonne, has been elected an honorary fellow of the Physical Society.

A LENGTHY catalogue (New Series LX.) of new and second-hand books and periodicals on zoology and biology has just reached us from Messrs. G. E. Stechert and Co., 31 East 10th Street, New York. The prices asked, in American currency, appear to be reasonable.

MESSRS. Longmans, Green and Co., Ltd., will shortly publish a new work by Sir Jagadis Chunder Bose on " The Nervous Mechanism in Plants." A further volume is to follow. Another forthcoming book in Messrs. Longmans' list is "A Manual of the Flowering Plants and Ferns of the Transvaal with Swaziland, South Africa," by Dr. J. Burtt Davy, in four parts; Part I.—Pteridophyta to Bombacaceæ. The four parts when completed will be issued in one volume.

MESSRS. Dulau and Co., Ltd., 34 Margaret Street, W.1., have just issued a catalogue (No. 139) which should be of interest to many readers of NATURE. It gives the titles of nearly 1400 second-hand works relating to astronomy, astrophysics, and the industrial arts, many from the library of the late Dr. W. H. Maw. Copies are to be had upon application.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant inspector for the examination of laboratory and general scientific instruments under the India Store Department—The Director-General, India Store Department, Belvedere Road, S.E.1 (March 30) A professor of anatomy at the Ceylon Medical College, Colombo—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1 (March 31). An assistant pathologist under the Metropolitan Asylums Board—The Clerk, Metropolitan Asylums Board, Victoria Embankment, E.C.4 (April 1). An investigator under the Safety in Mines Research Board to carry out work on the strengths of materials and structures for the support of underground workings in coal mines—The Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (April 6). A mycologist for the Forest Research Institute, Dehra Dun, United Provinces, India—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (April 7). A science master at the Lord Wandsworth Agricultural College, Long Sutton, Basingstoke—The Secretary, Lord Wandsworth College Trustees, 71 Piccadilly, W.1. A head of the department of hygiene and bacteriology and part-time lecturer in hygiene and maternity and child welfare at King's College for Women (Household and Social Science Department); also a part-time lecturer in economics—The Secretary, Campden Hill Road, W.8. An assistant lecturer in hygiene and public health at Battersea Polytechnic—The Principal.

Our Astronomical Column.

AURORAL DISPLAY OF MARCH 9.—A display of the Aurora Borealis causing widespread interest was seen from a number of places in the south and east of England during the evening of March 9, between half-past seven and half-past eight. It was visible, at least partially, from the suburbs of London, its probable commencement being noted by two members of the staff at Greenwich Observatory at $19^h 30^m$. Communications we have received from Mr. R. T. Gunther of Oxford and Mr. C. Leaf of Cambridge give interesting details of the rapid changes invariably associated with this phenomenon.

As seen from Greenwich, with the glare of the lights of east London to the north of the Observatory, the aurora appeared between $19^h 30^m$ and 20^h as a changing and indefinite area of suffused light, of a dull flame colour in the north-west and for a short time in the north-east sky. At Cambridge and Oxford a number of variable bands and streamers were visible, being at first white or greenish in the north and reddish in the north-west. Immediately after 20^h, Mr. Leaf states: "The pink colouration [of the streamers] became very strong, changing to a dark but intensely luminous red. At the same time the red streamers became a luminous patch which rapidly spread across the sky through north to east. At the western end of this band was a vast red patch which, starting at the horizon, reached almost to the zenith forming a most beautiful spectacle."

Mr. Denning, writing from Bristol, states that at $19^h 30^m$ an intense red glow was diffused along the northern horizon. This quickly faded and then rapidly increased in brightness, streamers developing at 20^h. "In the north-west . . . a broad column of white light 4° in width and apparently double became exceedingly conspicuous. It immediately widened until it consisted of a mass of rays 20° in width and the colour changed to an intense red."

An examination of the magnetograph traces at Greenwich shows that the magnets began to be noticeably disturbed at $19^h 30^m$, and at $20^h 5^m$ the Declination magnet was suddenly deflected 35′ towards the east. The magnet recovered its normal position by about 21^h, but it continued to show minor disturbance until the following morning. At the time, a large group of sunspots (see NATURE, March 6 and February 27) was very near the sun's west limb. There was, however, no large spot near the central meridian, although one of comparatively minor importance was slightly east of the meridian, in latitude 21° north, in a part of the sun not active in spots recently.

ENSOR'S COMET.—There is abundant evidence that Ensor's comet is now much fainter than was expected from its appearance in the southern hemisphere in January. It has evidently expanded greatly since perihelion passage, and now fills the whole of an ordinary telescopic field, so that the lack of contrast makes visual observation very difficult.

Mr. B. M. Peek, of Herne Bay, obtained a photograph on Wednesday morning, March 10, which shows a large faint nebulous blur so close to the tabular position of the comet that identity with it is probable. It may be recalled that Holmes's Comet in 1892 underwent a similar expansion which rendered it unobservable for a time. There was then a recrudescence of brightness at the nucleus, which later expanded again. The possibility of similar changes in the present case should be borne in mind. As the comet is now becoming circumpolar, it is well placed for observation. The following ephemeris is for 6 A.M.

		R.A.	N. Decl.	log r.	log Δ.
March	20.	$22^h 17^m 48^s$	58° 12′	9·9928	9·9616
,,	24.	22 59 21	65 27	0·0265	9·9847
,,	28.	23 58 59	70 59	0·0572	0·0134
April	1.	1 19 32	74 17	0·0855	0·0455
,,	5	2 48 24	75 14	0·1114	0·0790
,,	9.	4 5 7	74 20	0·1353	0·1124

NEPTUNE'S SATELLITE.—A paper by Prof. Eichelberger, Director of the American Nautical Almanac, was read at the meeting of the Royal Astronomical Society on March 12, in which all the observations of Neptune's satellite from its discovery until the year 1923 were discussed. The work was commenced by Prof. Newcomb, but left unfinished at his death; his computations were utilised, but they have been greatly added to. A splendid series of observations by Prof. Barnard extending over twenty-five years deserves special mention. The period of revolution of the pole of the satellite's orbit about Neptune's north pole is found to be 585 years. The eccentricity of the orbit is very small, about 0·0049, but its reality appears to be shown by the fact that, when the observations are grouped by observers, each series indicates motion of the apse in the same direction, this being the opposite direction to that of the node, as it should be. The values found for the annual motion of the apse vary from 1·5° to 3·0°, but are very uncertain.

Dr. Jackson used Prof. Eichelberger's results to obtain an estimate of the period of Neptune's rotation. On certain assumptions as to the distribution of matter within the planet, he found the period 19^h; but he thought it quite possible that the true period was double the $7^h 50^m$ announced by Maxwell Hall from photometric observations, and afterwards supported by Opik and Liviander at Tartu.

THE DISTRIBUTION OF NON-GALACTIC NEBULÆ.—Some years ago a series of photographs of selected areas were taken by Fath for the purpose of the Mount Wilson Catalogue of Magnitudes. The limits of magnitude photographed were so low as 18 to 19 on the international scale, and counts were made of the nebulæ found in each area. These counts are re-examined by F. H. Seares in the *Astrophysical Journal*, vol. 62, p. 168. The selected areas are 139 in number, distributed at intervals down to 15° South Declination, and are arranged by Seares first to show the distribution of the nebulæ in galactic latitude. The diagram shows the gradual appearance of nebulæ at about 20° latitude (in both hemispheres), followed by a rapid increase in numbers up to 30°. The well-known concentration near the galactic poles is shown in the case of the North Pole, but the south polar region is not included among the selected areas. The distribution in galactic longitude is interesting in showing strong evidence of a band of nebular concentration crossing the North Pole in longitudes 50°-220°. It appears, however, that the distribution in longitude depends on the size of the nebulæ under consideration. The majority of those discussed by Seares are very small, having diameters of less than 30″. An estimate is made (after allowing for losses arising from aberration) of the total number of nebulæ in the sky. This number (estimated at 300,000) is considerably smaller than that given by Curtis (722,000); and though there is a source of error in the asymmetrical distribution of the photographs, Seares considers that it is insufficient to reconcile the considerable discrepancy between his estimate and that of Curtis.

Research Items.

The Aurignacian Station at La Quina (Charente).—In the *Bulletin of the Société d'Anthropologie de Paris*, Ser. 7, T. 6, Fasc. 1-3, Dr. Henri Martin gives an account of the Aurignacian levels of the well-known site of La Quina, where he has been engaged in systematic exploration since 1908. Although the site was brought to the notice of archæologists in 1884, when Dr. Martin first visited it in 1905 he could find no trace of any attempt at systematic or scientific investigation outside the excavations made in the course of the original road-making operations. Dr. Martin's investigations have revealed that the area of occupation was situated at the base of the cliff. The Aurignacian levels, three in number and superimposed, are on material brought down by land-slides, beneath which at the bottom is a Mousterian station. Over this station the debris formed a mound four metres thick and forty metres in extent, separated from the cliff by a hollow ditch in which was found the refuse of the earliest Aurignacian settlement, consisting of broken bones, in particular those of the reindeer and the horse, calcined stones and relics, broken and whole, of the industries of the inhabitants. On each of the occupation levels were layers of fallen material similar to that overlying the Mousterian and separating the stations one from another. Of the Aurignacian levels, the first or lowest and the third are the most important. The absence of audi points and of transitional forms in the lowest station showed that a certain development in culture had already been attained. The characteristic form is a reindeer horn assegai or lance head, flattened, but not quite conformable to the usual type. No graves were found and no example of artistic activity has come to light. The station belongs to the Lower Middle Aurignacian, and is comparable to Isturitz The middle station contains no specially characteristic features, and occupation was probably not prolonged. In the uppermost level of occupation the characteristic implement is the keeled scraper, and its culture is comparable with that of the Boulton site.

Buddermokan.—In the *Indian Antiquary* for February, Sir Richard Temple publishes the first part of some notes of investigations made some years ago into the question of a seamen's spirit of which the shrines, known to Europeans as Buddhamakam, are found along the coast of Burma from Akyab to Mergui. These shrines have no connexion with Buddhism. They are universal, being accepted by Buddhists, Hindus, and Mohammedans alike, and by natives of India, Burma, and China, a sign that they are symbols of the animism which underlies all Indian religions. Their chief votaries are sailors, fishermen, and those who obtain a livelihood by the water The name is Indian, not Burmese, and Mohammedan in origin. It is properly the shrine of Badar--Badarmaqâm, who is Pir Badar of Chittagong, known to Indian Mohammedans as Badru 'ddin Auliâ, who represents by his attributes Khwâja Khizar in modern Bengal. Khwâja Khizar in turn is Al-khidhr of the Koran, whose legend is mixed up with Mehtar Ilyâs, the prophet Elias of Jewish tradition, the Spirit of the Flood. This form of belief is still extant in Russia and finds expression in the water festival of the prophet Ilyâ. So far as the evidence obtained from Burma goes, it appears that at certain spots along the Burmese coast, at Akyat, Sandoway, and Mergui, a supernatural being is worshipped, his worship being mainly that common all over the east, *i.e.* it is a survival of a local animistic worship. Its connexion with Pir Badar is due to the fact that, as often happens, one of the local professed religions, in this case the Mohammedan, has annexed the supernatural being of the older belief and has identified it with the saint best known to the bulk of the sea-faring population, Pir Badar of Chittagong.

The Systematic Characters of Sea-Gulls.—There is a freshness of treatment and wealth of observation in Dr. J. Dwight's monograph of the world's gulls which make it invaluable to the systematist (*Bulletin of the American Museum of Natural History*, Dec. 31, 1925). Difficulties in the determination of species have always been involved in the complicated series of plumages gulls pass through before attaining finality, which vary from the two-year plumage-cycle of the small gulls to the four-year cycle of the large species, each year having its own non-nuptial and nuptial arrangements Consequently great attention has been paid by Dr. Dwight to the discrimination of the stages of immaturity, with the result that the description of a species, say the lesser black-backed gull, expands into an account of ten different stages of plumage, which, with an abbreviated synonymy, accounts of distribution and of the four geographical races, cover nine pages of print. The succession of changes is made readily intelligible by excellent diagrams of the colour patterns of the wings and tail of every species in every plumage, and the flesh colours of bills and feet of many species are accurately portrayed. Single type specimens no longer meet the needs of this detailed analysis of stages, so that a series of "reference specimens" is appended to each plumage. The author has examined each of the forty-four known species of gulls, and his classification remains conservative, though he creates a new sub-genus Saundersia for a Chinese species of Hydrocoloeus.

Canadian Salmon.—There have as yet been no published records of the examination of scales from Canadian salmon: Mr. Menzies' paper on the salmon (*Salmo salar*) from the River Moisie, flowing into the north side of the Gulf of St. Lawrence (*Proc. Roy. Soc. Edinburgh*, vol. 45, Pt. iv. No. 30), is welcome, therefore, as giving the first information on the life-history of the Canadian fish furnished by scale-readings. Unfortunately, the samples collected for Mr. Menzies for examination were small and cannot, as he admits, be considered as representative of the salmon population frequenting the river. The scale-markings resemble exactly those of the scales of Scottish fish: the period of slow growth is well-marked. Scales taken from fish in June and early July showed that 81 per cent. were 'spring' fish; in Scotland at this period one expects clean-run fish to be almost exclusively 'summer' fish. The majority were 'maiden' salmon returning from the sea after three winters. Grilse were absent from the sample. The spawning-scar, when it occurred, was clear and showed that 16·7 per cent. were spawned fish, as compared with the usual 4 per cent. on the east coast of Scotland; most had spawned once, but the numbers with two and three spawning rings were noteworthy; one even was returning to spawn a fifth time. The average age of the smolts at migration was between that of smolts from the north-east of Scotland and smolts from Norway. The three-winters fish were fat and well nourished, comparing favourably with the most finely shaped Scottish fish. Length calculations from scale measurements did not differ materially from those of Scottish salmon.

A PECULIAR PARASITIC CRUSTACEAN.—Prof. T. Komai describes (*Mem. Coll. Sci., Kyoto Imp. Univ.*, vol. 1, No. 3, Oct. 1924) a new species of Sarcotaces, fourteen examples of which were found embedded in the subdermal connective tissue of Antennarius. Their presence causes prominent lumps on the surface of the fish. Each individual is enclosed in a thin sac formed of the host's connective tissue, and the sac has no opening to the exterior. The parasite, which varies in length from 5 mm. to 15 mm., is rounded anteriorly and pointed posteriorly, and exhibits eleven segments, the first six of which constitute the cephalic and thoracic region and the last five the abdomen. In the first segment is a small mouth bordered on each side by a hand-shaped process—possibly the maxilla. Farther back is another pair of processes—possibly the vestigial maxillipeds. There are no antennæ and no limbs. The mouth leads into a blindly ending gut which contains dark particles, apparently the coagulated blood of the host, intermixed with muscular and connective tissue fibres. The ovary is freely branched; the oviduct arises in the sixth segment and opens near the anterior margin of the seventh, but continues backwards round the blind end of the alimentary sac and unites with the corresponding oviduct of the other side. On each side in the lateral region of the second segment is a testis, the lumen of which is continuous with that of a neighbouring branch of the ovary. In the fluid which fills the space between the body and the enveloping sac were found numerous developing eggs and free nauplius larvæ. The two previous observers—Olsson and Hjort—who have investigated Sarcotaces, placed it respectively in the Copepoda and in the Cirripedia. Prof. Komai agrees with Olsson's view, because the opening of the oviduct is in the first abdominal segment, and in the nauplius anterolateral and anal spines are absent. The two previously known species of Sarcotaces were obtained from fishes taken off the West Indies and off Norway. The present species is regarded as new (*S. pacificus*)

INFLUENCE OF ROOTS OF WALNUT TREES UPON OTHER PLANTS.—A. B. Massey has an interesting paper upon this subject in *Phytopathology* for December 1925 (vol. 15, pp. 773-784). He gives very convincing evidence that the presence of the roots of walnut trees in close contact with the roots of lucerne, tomato, and potato is responsible for the wilting and death of these other plants. The effect does not spread from the walnut tree roots generally into the soil, and is only produced when the walnut roots lie in close contact with the root system of the other plant. An extract of the bark of the walnut root is shown to have a toxic action upon the roots of, the tomato plant grown in water culture, and it is suggested, but not experimentally established, that the action of the walnut roots is produced by a toxic constituent substance, juglone, which is a naphthaquinone.

TREATMENT OF GRAIN FOR BUNT.—The treatment of bunt (caused by *Tilletia tritici* and *T. lævis*) with solutions of copper sulphate on formalin, as is usual, is open to the objections that the wheat seed has to be dried before sowing, and that care is needed to avoid the use of too strong solutions, which would injure the grain. Experiments on dry treatment with copper dusts have given very satisfactory comparative results, bunt being controlled, though not completely eliminated, by the use of such dusts (K. Sampson and D. W. Davies, *Welsh Journ. Agric.*, 2, 1925). The most successful applications were dehydrated copper sulphate and copper carbonate containing 50 per cent. copper, at the rate of 2 oz. per bushel of grain, other dusts with lower percentages of copper proving effective at ·4 oz. per bushel. On the whole, copper dusts were more efficient than formalin solutions, and had the advantage of eliminating risk of damage to the seed. The treated seed gave better growth in the field, with increased tillering and higher yield of grain, indicating that *Tilletia tritici* has some deleterious action on the plant apart from that caused by the replacement of healthy grain by bunted grain. The possibility exists of some stimulating action by the chemicals employed, and this is being investigated. The advantages of dry treatment lie in its convenience, as no solutions need making up, the grain is more easily handled at sowing time, and the dusting can be carried out at any time between harvest and sowing without danger of lowering the germination capacity of the seed.

INVESTIGATIONS ON POTATO DISEASES.—The growing importance of research on virus diseases entails constant seeking for new methods of investigation, of which some of the more recently devised are described by P. A. Murphy and R. McKay (*Sci. Proc. Roy. Soc. Dublin*, vol. 18, January 1926). Investigations are much hampered by the usual necessity of conducting experiments in insect-proof houses, but for experiments that can be completed in one year this is obviated by a new method of grafting by cores inserted from one tuber into another, planting being done in the open. Mosaic diseases are transmitted freely by using infected cores, but leaf roll does not appear to be transmittable unless the tubers are kept in the cold after grafting. This affords a useful means of separating mosaic from leaf roll infection by keeping the grafted tubers at about 20° C. before planting. If leaf roll infection is desired, cleft grafting on the sprouts is a very useful method of obtaining tuber infection. Cleft grafts are also reliable for infecting stalks and foliage, all diseases and combinations being equally transmitted, except occasionally streak, the latter, however, being readily transmitted by leaf mutilation. The rate of spread of virus in the potato plant has been studied by infecting single-stemmed plants at the top, and then removing the lateral shoots at intervals and growing them as cuttings, or by similarly removing tubers. In such plants the virus spreads to all parts of the stem and tubers after an interval of more than 8 to 10 days and less than 14 to 15 days. Further work deals with the isolation of streak, which causes much trouble in endeavouring to isolate other diseases, as it is frequently present in certain varieties of potatoes in which it does little or no harm and where its presence would never be suspected.

PLANT CUTICLES IN COAL.—Ordinary domestic experience convinces many of us that there are wide differences in coals. When it is considered what extensive vegetable remains must be embodied in the coal and what a varied panorama living vegetation provides, the fact seems less surprising if none the less annoying on occasion. Obviously not only the method of preservation, but also the nature of the original vegetation concerned must affect the quality of the coal, and from this point of view attention is being directed, under the ægis of the Safety in Mines Research Board, to the identification of characteristic vegetable debris, with the view of seeing whether any special properties, such as inflammability, show correlation with particular vegetable components. As Paper No. 17 of the Research Board (London: H.M. Stationery Office, 1926; 1*s.* net), V. H. Legg and R. V. Wheeler publish an account of their study of the chemistry of the cuticle of a living plant, *Agave americana*, and of the well-known paper coal from the Moscow basin, which consists almost entirely of compressed plant cuticles. They find this paper coal to be only very slightly attacked by alkalis. The authors state that they are now engaged in the separation of cuticles from bituminous coal by a method which leaves them unaltered in composition, with a view to their further chemical study. It must not be forgotten, however, that there are other fat impregnated layers, at least in living plants and peat deposits, which are likely to be as well preserved in coal as cuticles, and it is not clear that some of the excellent photomicrographs in Plate IV., described as of cuticles from bituminous coals, necessarily represent cuticles at all.

New Mexican Land Shells.—There seems to be always something new from Mexico in the way of land shells. Two more papers have lately appeared. Dr. P. Bartsch describes (*Proc. U.S. Nat. Mus.*, 77, art. 22) three new species of Holospira. Dr. Pilsbry and Prof. Cockerell (*Proc. Acad. Nat. Sci. Philad.*, 77) deal with a series of shells belonging to several genera including two new species of the carnivorous Glandina, bringing the total number of species of that genus known from north-western Mexico up to ten. They further describe a very handsome little helicoid, *Polygyra nayarita*, n. sp., from the State of Jalisco, Central Mexico.

Paragenesis of Pegmatites.—An important study of the minerals and their sequence in certain of the granitic pegmatites of Maine has been carried out by K. L. Landes, and the results are published in *The American Mineralogist*, vol. 10, 1925, pp. 355-411. The original pegmatite magma crystallised after the manner of a granite, accessories including tourmaline and beryl being followed in turn by microcline and quartz. Mineralisation then continued through the agency of ascending solutions which were also responsible for the development of pockets and cavities. A high-temperature hydrothermal phase came first and introduced minerals such as quartz, cleavelandite (albite), and various lithium-bearing species. Then followed an intermediate phase in which many rare lithium-manganese phosphates were deposited. The third and final phase is represented typically by quartz, cookeite (a lepidolite-like mineral), and purple apatite. Weathering by groundwaters was responsible for the last crop of minerals produced, the chief alterations being to clay minerals and manganese hydroxides. Many of the minerals, including some remarkable quartz pseudomorphs, are described in detail with analyses.

The Geology of South Africa.—The Geological Survey of the Union of South Africa has just issued a geological map of the Union on the scale of one to a million. The map is a revision of one that was compiled for and exhibited at Wembley. It now appears in four unmounted sheets, each 38 in. by 28 in. (Price 25*s.*) The colour scheme has been well chosen, and the printing and registration carefully executed. In all, 29 different formations are distinguished, and nowhere is there any source of confusion either in geology or topography. An explanation of the map (sold separately at 6*d.*) by the Director, Dr. A. W. Rogers, provides a valuable summary of the geological structure of the Union. An account of the physical features is followed by a description of the geological history and the outstanding structural features, and the pamphlet concludes with a table of formations, igneous intrusions, and earth-movements. The chief differences from former interpretations are (*a*) the removal of the Vredefort granite from the end of the Witwatersrand system, (*b*) the transferring of the former Lower Waterberg to the Upper Transvaal, (*c*) the assignment of the Bushveld complex to the Upper Transvaal, and (*d*) the inclusion of the Pilandsberg alkaline rocks with the Cape System at its base. The Swaziland system remains, as formerly, a convenient class into which all the older rocks are placed pending more satisfactory evidence of their ages. There is still no means of deciding whether the Transvaal system is Palæozoic or pre-Cambrian. This is a case where a determination of the age of the younger granites or of the Bushveld complex by radioactive methods would be of the utmost importance. At the moment one can only direct attention to the lead-ratios of the Katanga (probably Ordovician) and Morogoro (probably Late pre-Cambrian) uraninites. These suggest that the equivalents of the Transvaal and Waterberg systems are respectively of pre-Cambrian and early Palæozoic dates.

Rainfall of the Dutch East Indies.—The Royal Magnetical and Meteorological Observatory of Batavia has published volume 2 of a monograph on the rainfall of Java and Madura based on the observations of several hundred rainfall stations during the period 1879–1922. The atlas consists of fifteen beautifully printed maps on a scale of 1 to 1,000,000. Relief of the highest ground is shown by hill-shading. The first map shows the location of the stations, while the others give the mean annual and the monthly rainfall. Volume 1 of the monograph is to contain the tables and volume 3 the text. The text is in both Dutch and English.

Squalene.—An account of further research on the unsaturated hydrocarbon squalene, occurring in large amounts in certain shark-liver oils, appears in volume 1 of the *Scientific Papers of the Institute of Physical and Chemical Research, Tokyo*. Decomposition of the hexa-ozonide, together with other facts, show that squalene is a higher aliphatic terpene.

Inversion of Cane-Sugar.—The kinetics of the inversion of cane-sugar in acid solution have been reinvestigated by S. W. Pennycuick, of the University of Adelaide, whose results are given in the January number of the *Journal of the American Chemical Society*. In the presence of a large excess of water the reaction

$$C_{12}H_{22}O_{11} + H_2O = C_6H_{12}O_6 + C_6H_{12}O_6,$$

first investigated from this point of view by Wilhelmy in 1850, is usually assumed to be unimolecular, since the active mass of the water remains practically constant. According to the investigations of Worley in 1911 the unimolecular law is not followed, and Armstrong and Caldwell in 1905 asserted that, with weak acids, the earlier stages are represented by a linear and not a logarithmic concentration-time formula. Other observers state that the unimolecular law holds with weak acids but not with strong acids, whilst a number of investigators claim that the inversion process follows the unimolecular law within the limits of experimental error. The principal advance claimed in the above investigation is the elaboration of three methods by means of which the rotation at zero time may be directly determined. In this way it was found that the velocity constant k increases slightly and steadily during the inversion, the maximum increase not exceeding 5 per cent. The very constant results of other workers are probably vitiated by errors which are discussed in detail. The hydrogen ion activity also shows an increase, as measured by the hydrogen electrode, of from 1 to 3 per cent. during inversion, according to the strength of the acid used. The use of the bimolecular equation: Velocity $= k$(sucrose)(water) is shown to be unsound, and the inversion is best represented by the equation: Velocity $= k$(sucrose molecules per molecule of water)(H ion activity).

Archæology and Natural History in Lithuania.[1]

PREHISTORIC FLINT IMPLEMENTS.

AMONG the many remarkable achievements of archæological research during the last few years, not the least noteworthy has been the piecing together of the evidence for bridging the gap which, it was once almost an article of faith to hold, lay between the palæolithic and neolithic periods of the stone age. Dr. F. Birkner has recently added to the record of sites in eastern central Europe from which evidence has been obtained bearing upon this still obscure question. During the War a collection of stone implements was made by Dr. E. Stechow while on a zoological expedition in Lithuania. The implements were surface finds and came from Zubrovo, 55 km. north-east of Grodno on the banks of the Kostra, an affluent of the Niemen, from the shores of Lakes Bersztу, Oziery (Jeziory), and Nowaja Ruda. According to the description furnished by Dr. Stechow, the sites on which they were found agree in being strips of dry open land in the neighbourhood of marshy ground running along streams or on lake shores. Sometimes they are backed by wooded or forest land. Prof. Birkner compares a number of stone age sites in Lithuania recorded by Wandalin Szukiewicz from the banks of the rivers Mereczanka and Gruda and the Stegela, Ula, Duba, and Pielasa lakes.

The implements found by Dr. Stechow included knives of various forms, points of various types, arrowheads with concave bases, implements of geometrical form, triangular and trapezoidal, various forms of scrapers, gravers, axes, some of the latter of characteristic Scandinavian type. He refers to similar types recorded by Szukiewicz, and in both cases compares them with finds in Bavaria made during the last ten years in the neighbourhood of Lichtenfels. At Schönsreuth in particular a large number of scrapers and geometrical implements of Tardenois type was found, also at Ansbach and at Neumarkt. It is evident that a large proportion of the implements are of a character typically Tardenoisian. Dr. Birkner goes on to point out certain features which he maintains are common to the sites. They are for the most part located on open ground, sand, loam or gravel, sometimes, as in Lithuania, near marshy ground or on the shores of rivers and lakes. The implements themselves include gravers, which are to be referred to a palæolithic type, while they also include forms neolithic in character, as for example the axes and chisels. Taking all the circumstances into account, his conclusion is that they represent a distinct culture—*Oberfläschensteinzeit* as distinguished from *Wohngrubensteinzeit*. This culture belongs to a people living in dry open spaces, by fishing primarily and by hunting. The survival of palæolithic and relation to or occurrence of neolithic forms indicates a true transitional phase.

Taking these facts, and the distribution of the "*Oberflaschensteinzeit*" culture into account, Dr. Birkner takes a different view of the Tardenoisian and Azilian culture from that of Obermaier, who brings the Tardenois culture into relation with the Late-Capsian of Spain, from which centre it is distributed over middle and northern Europe, and groups together Late Capsian, Tardenois, and Azilian as Epipalæolithic. Dr Birkner, however, would regard the Tardenois culture of the "*Oberfläschensteinzeit*" as a true mesolithic culture developed by a hunting and fishing people, and distributed from eastern Europe as a centre to Syria, North Africa, and western Europe. Further, he holds that the progressive deterioration in the size of palæolithic implements, which reaches its extreme in the Tardenois types, is related to changes in the climate during the period.

While the evidence relating to this obscure period of prehistory is still far too scanty to justify dogmatic statement, an alternative explanation of the variety of forms to which Dr. Birkner refers may well be possible. The conditions in which these collections of varying types are found inevitably suggests the possibility of either a succession or an impact of cultures at different stages of development. Apart from this, the evidence of distribution is at present too slender to support his view; indeed it seems to point in the opposite direction.

BIRDS.

It is well known that during the War the advancement of science in many branches was not left out of sight, even close to the front. British and German men of science and collectors at least have done work on the eastern and western fronts in Europe, Mesopotamia, East Africa, and elsewhere. In Germany specialists were appointed and worked under the protection of and assisted by the military authorities in several places. Ornithologists are familiar with the "Avifauna Macedonica" by Dr. Stresemann, based on a collection of 3258 bird-skins made by the "Macedonian Scientific Commission," which appeared in 1920. The work before us gives the ornithological results of Dr. E. Stechow's explorations in Eastern Lithuania, chiefly north-east of Grodno, now belonging to Poland.

These countries are of special zoogeographical interest, because in them is found the boundary for several species with eastern and western representatives, which actually meet in Lithuania, and in some instances interbreed. Unless such subspecies are separated by obstacles like sea, desert, or enormous mountain ranges, their boundaries are often not quite sharp, forms either frequently interbreeding where they meet, or overlapping. The collection of 703 skins, however, gave also opportunities to study individual, sexual, and seasonal differences, and time and manner of moult. The author has, with full regard to the literature on the subject by Russian, Baltic, and more recently by a number of German ornithologists, made excellent use of the material entrusted to him. Of the many more interesting details the following may be pointed out.

The west European carrion crow, *Corvus corone corone*, is entirely replaced by the hooded crow, which the author regards as a subspecies of the former, calling it *Corvus corone cornix*. The jackdaw agrees fully with the Swedish *Coloeus monedula monedula*, and the author seems to doubt that *C. monedula soemmeringii* is separable. Both species of tree creepers are found, *Certhia familiaris* common, *C. brachydactyla*, which finds in Lithuania its north-eastern limit, rare.

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[1] Abhandlungen der math.-phys. Klasse der Bayer. Akademie der Wissenschaften. Beiträge zur Natur- und Kulturgeschichte Lithauens und angrenzender Gebiete. Herausgegeben von Prof. Dr E. Stechow.

Einleitung, von Prof. Dr. E. Stechow. Vögel, von Dr. H. Sachtleben. (Suppl.-Band. Einleitung und 1 Abhandlung.) Pp 232.

Steinzeitliche Funde aus Lithauen, von Prof. Dr. F. Birkner. Parasitische Insekten aus Lithauen, von Prof. Dr. Günther Enderlein. Parasitische Trematoden aus Lithauen, von Dr. L. Scheuring. Biologische Beobachtungen, von Prof. Dr. E. Stechow. (Suppl.-Band. 2-5 Abhandlung.) Pp. 233-256+6 Tafeln.

Die Zweiflügler des Urwaldes von Bialowies, von Prof Dr. P. Sack. Hymenoptera (Aculeata, Ichneumonidae, Chalastogastra), von Dr. H. Bischoff. Trichopteren und Ephemeropteren aus dem Bialowieser Wald, von Dr. G. Ulmer. Über Waldbienenzucht in Lithauen und einigen Nachbargebieten, von Dr. H. Klose. (Suppl.-Band. 6-9 Abhandlung.) Pp 257-406+9 Tafeln.

(München: Verlag der Bayerischen Akademie der Wissenschaften.)

Of the nuthatch, two forms occur, called *Sitta europaea europaea* and *S. eur. homeyeri*. This led the author to review the European forms of Sitta in 26 pages, and to supply a large folding map, showing their distribution and representing nine forms in colour. He explains that the extremes are very different, and must be named *Sitta europaea europaea* (Sweden) and *S. europaea cisalpina* (Italy), the former being the whitest, the latter the most richly coloured one, and that *caesia* (western and central Europe generally) and *homeyeri* (East Prussia, Baltic States) might have names, but that the various forms completely merge into each other; therefore he rejects the use of the names *sordida*, *reichenowi*, and *stolcmani*, as given to changeable, insufficiently defined units. He thus does not differ much from the arrangement in the "Vogel der palaarktischen Fauna," vol. 1 (1905), except that there the Italian form was only indicated, but not supplied with a name; of the British form with its pallid underside and the Spanish-Moroccan one he had no specimens to examine, and therefore only alludes to the former without comment.

The Lithuanian long-tailed tit belongs to the northern subspecies with entirely white head, *Aegithalos caudatus caudatus*, while the British form has wide black lateral stripes, and in central Europe a form is widely spread with the head either pure white without or with lateral black stripes. Of the genus Regulus (Goldcrest) only *R. regulus* is found, as in England, while in central Europe two species, *R. regulus* and *R. ignicapillus*, occur side by side, the latter becoming dominant in southern Europe, and being the only one inhabiting the forests of north-west Africa (Morocco, Algeria, and Tunisia). Woodpeckers are very well represented; besides the three British species (all in different subspecies), the black, the white-backed, the middle spotted, and the three-toed woodpecker inhabit the vast forests, the latter in a differentiated new subspecies, called *Picoides tridactylus stechowi*.

Where different geographical forms are separable, the northern one is in nearly all cases the one found in Lithuania. Exceptions are the bluethroat (*Cyanosylvia svecica cyanecula*) and the yellow wagtail (*Motacilla flava flava*), which are represented by the central European subspecies, while of Sitta the northern and central European forms meet, Picoides being intermediate between the northern and central European (mountain) forms, and the crested lark (*Galerida cristata*), and the buzzard (*Buteo buteo intermedius*) showing eastern influence.

Insects.

Four articles in the publications under notice are devoted to the natural history of Lithuania and neighbouring provinces. The first article (pp. 259-277) is by Dr. P. Sack, of Frankfurt a. M., and contains an enumeration of Diptera found in the "Urwald von Bialowies." In so far as certain families are concerned, the list is evidently far from complete, and the Brachycera and Cyclorrhapha appear to have been better worked than the Nematocera. The region is apparently rich in Syrphidæ and the larger Asilidæ, no less than seven species of Laphria, for example, being recorded.

Dr. H. Bischoff, of Berlin, gives a general list of the Lithuanian Hymenoptera, including the aculeates, ichneumons and saw-flies. This contribution appears to be remarkably complete, and it includes useful data respecting localities and times of occurrence. Of the Aculeata it is a matter of interest to British entomologists to note that the genus Bombus is represented by twenty species and numerous varieties, while Psithyrus only comprises the same six species that occur in Britain. There are seven species of Vespa, two of which, *media* and *saxonica*, do not occur in Britain. The Chrysididæ are represented by seven genera and eighteen species. The region appears to be rather poor in ants, only twelve species being recorded. There is a long and valuable list of Ichneumonidæ and the Tenthredinoidea are tolerably well represented. The Trichoptera and Ephemeroptera of the Bialowieser Wald (pp. 339-342) are listed by the well-known authority, Dr. G. Ulmer of Hamburg; in the first-mentioned order forty-three species are enumerated, but only five species of Ephemeroptera are recorded.

The fourth article (pp. 343-406) is by Dr. H. Klose, of Berlin, who gives a very full illustrated account of the history and practice of bee-rearing in the forest regions. Of special interest are the curious vertical log-hives used in that part of the world. Some of the older forms of these are carved with bizarre human effigies and several are figured from the "Brandenberg Beweherte Bienen-Kunst," dated 1696.

Annual Meeting of the Association of Technical Institutions.

THE annual general meeting of the Association of Technical Institutions was held in Regent Street Polytechnic on March 5 and 6. The new president (the Marquis of Londonderry) was unable to be present, and his presidential address was read by Lord Emmott, who prefaced his reading with a reference to the unofficial Committee which is at present inquiring into the relationship of technical education to other forms of education and to industry.

That the time is ripe for such an inquiry became evident during the Conference. Three of the papers submitted dealt with the education of employees in distributive trades—a matter which has hitherto received little attention. Prof. Knox's paper on "Recent Developments in the Teaching of Mining in Technical Colleges" was particularly noteworthy in view of recent suggestions that the mines of Great Britain are inefficiently equipped and managed. His description of the general manager (whose staff organisation has three main divisions: colliery engineering, colliery managing, and chemical engineering) is illuminating and deserves reproduction:

"He is by innumerable Acts of Parliament held legally responsible for the safety of all workmen in and about the mines. Besides having to supervise all the work of . . . engineering departments he must be fairly expert in Geology and Surveying . . . He must have an extensive knowledge of the Laws relating to Coal Mines, Use of Explosives, Use of Electricity in Mines, Workmen's Insurance and Compensation . . . the Law relating to Leases, Surface Supports, Trespass, Leasehold, and Copyhold, Railways, Local and Imperial Taxation, etc. Last, but most important of all . . . he requires to have a knowledge of psychology and be imbued with a broad understanding in the handling of workmen."

Lord Londonderry's theme included the twin problems of the increase in the numbers entering the 'black-coated' professions and the serious lack of skilled manual workers (which will be felt most keenly when industry revives). In spite of the development of scientific appliances and automatic machinery, he insisted upon the continued necessity for good craftsmanship, and submitted that preference is being given to 'black-coated' occupations because of causes not often considered. In the past we have allowed the manual worker to become skilled at the expense of his intellectual equipment: his formal education usually ceases after the elementary school—a matter which needs attention if there is ever to be a redress of the social balance to the advantage of the craftsman as opposed to the clerk. During recent years, too, there has been the factor of the enhanced cost of living: boys must earn quickly, and 'blind-alley' jobs have been accepted eagerly. Further, there can be no doubt that, not only does unemployment fall most heavily on the skilled worker during trade depression, but wages, too, in those times, fall below those for unskilled work. What incentive is there for parents to send a boy to a long apprenticeship if, at the end, he may receive 10*s.* per week less than an unskilled man? The obsolete apprenticeship system is a final point requiring reconsideration: among the many things the War taught us is the fact that a long apprenticeship is not always necessary for the production of skilled workers.

The most animated discussion of the Conference, however, centred round the question of 'Adult Education.' A Board of Education Circular (1355) appears to encourage local education authorities to organise and control 'adult education,' although intimate administration might be delegated to voluntary organisations acting as advisory committees or managing bodies. Prominent among such organisations is the Workers' Educational Association, but opinion concerning it appears to have been divided because it is alleged to have ceased to be an entirely independent organisation since it became one of the contributory bodies to a new scheme with the Trades Union Congress, and must therefore tend to be governed by the latter in its educational policy.

As part of the Conference, a paper on "The Place of the Local College (Technical Institution) in Adult Education" was read by Prof. Peers, and, in the discussion, opinion was divided as to whether local education authorities should, or should not, accept financial responsibility for this type of education. The whole matter is to be discussed further, but it is to be regretted that no one attempted to define 'adult education.' Education has suffered considerably from the tendency to divide it into watertight compartments. Already we have elementary, secondary, technical, and university education. Now another term is used to describe something which is looked upon as another compartment. No wonder there is confusion of objects and aims! A body of students (age 20 years plus) under a voluntary organisation studies psychology; that is 'adult education.' Students of the same age study engineering or commerce (in their broadest implications) in a technical institution: this type of education appears to be regarded as outside the field of adult education.

An ancient error still persists. Technical education is regarded as synonymous with vocational instruction. What are the facts? In most technical institutions the course subjects are so presented that they become an education liberal in the fullest sense. Again, in such schools there is always a large percentage of students taking subjects which are thoroughly non-vocational. These facts do not appear to be well known. The inquiry referred to by Lord Emmott is therefore timely.

The Fate of the Hexosephosphoric Acid Esters in the Mammalian Organism.

THE importance of compounds of hexose and phosphoric acid, both in the intermediary metabolism of carbohydrates and in the process of ossification, is now well established. One need only mention the origin of the lactic acid of striated muscle from a hexosediphosphate, the connexion between inorganic phosphorus and glucose in the mechanism of the action of insulin, the occurrence of hexosephosphates in the fermentation of yeast, and the hydrolysis of one of these esters present in the blood by means of extracts of bone. But our knowledge of their physiology is still very incomplete, so that interest is attached to any work which helps to fill the gaps O. Fürth and J. Marian (*Akad. Wissensch. Wien*, 1925, No. 18, p. 175) have attempted to follow the fate of the hexosediphosphoric acids in the mammalian organism, by injecting a pure neutral or acid sodium salt subcutaneously into dogs; this route was chosen in preference to feeding by mouth in order to avoid any bacterial decomposition in the intestine. It was found that the diphosphate was broken down; part of the phosphorus appeared in the urine as inorganic phosphate, but about half was retained in the body, together with all the hexose. The authors suggest that the portion retained was utilised by muscle in the formation of lactacidogen. No effects were produced on the general metabolism even by doses so large as 40 gm. per kilo. body weight. It is of interest to note that some preliminary chemical experiments have led the authors to suggest that the molecules of these compounds may possess a cyclic structure.

Fürth and Marian have shown that a hexosediphosphate can be utilised by the body after parenteral administration. H. D. Kay in some recent work (*Biochem. Journ.*, 1925, vol. 19, p. 433) has brought forward some evidence as to the tissues in which this destruction occurs. In an investigation into the phosphorus compounds of milk, he has found at least two organic acid-soluble phosphorus compounds in cow's, goat's, and human milk, one of which is readily hydrolysable by tissue extracts whilst the other is more stable. The fact that muscle extract does not hydrolyse the compounds at all readily suggests that they are not of the yeast hexosediphosphate type, although preliminary experiments indicate that the one, which is attacked by bone enzyme, is probably a hexosephosphoric acid ester. Of more interest in connexion with Fürth and Marian's work is the finding that the compounds present in milk are not attacked by saliva, gastric or pancreatic juice, but are broken down by the intestinal juice. On the other hand, most of the tissue extracts examined were active in this respect, including both extracts of gastric mucosa and pancreas, although the external secretions of these latter were inactive

It appears, therefore, that hexosephosphates are hydrolysed in the gut before absorption, but the general presence of hydrolytic enzymes in the tissues implies that under suitable conditions the latter will be able to synthesise these compounds, as is also suggested by the fact that the esters occur in the circulating blood. Kay finds that phosphorus is present in milk in no fewer than eight different forms, including free phosphate, caseinogen, phosphatides and acid-soluble esters, and suggests that this abundance is to ensure adequate absorption of this element. The compounds will be hydrolysed at different levels in the gut, and it is thus possible that the concentration of PO_4''' ions will be kept so low that the solubility product of calcium phosphate is not exceeded, thus obviating the precipitation of this insoluble salt in the alkaline or neutral contents of the intestine, with the resultant loss of both calcium and phosphorus in the fæces.

University and Educational Intelligence.

ABERDEEN.—Mr G Leslie Purser has been appointed lecturer in embryology. Mr. W. H. Bruford, reader in German, Mr. J. Macfarlane, reader in geography, and Dr. J P Kinloch, lecturer in public health, have been appointed members of the Senatus Academicus.

The University Court has resolved to institute a post-graduate course of study in the faculty of medicine, during the ensuing summer term, for the benefit of practitioners in the north-east of Scotland.

CAMBRIDGE —Mr. A Hutchinson has been reappointed demonstrator in mineralogy and assistant curator of the Mineralogical Museum.

L R Bishop, scholar of Trinity College, has been appointed to a Frank Smart studentship in botany. He was placed in Class I. in the Natural Sciences Tripos in 1925, and is engaged in research on respiration in plants.

Rayleigh prizes have been awarded to R C. Cooper, of Trinity College, and H Horrocks, of St. Catherine's College, for essays on "Some Inequalities applicable to the Theory of Functions" and "The Effect of Wind on Tides and Currents and the Decay of Waves in a Circular Basin" respectively

Smith's prizes have been awarded to G. S. Mahajani, of St. John's College, who wrote on the theory of ferromagnetic crystals, and Ll. H. Thomas, of Trinity College, whose essay dealt with Kronecker's theorem in relation to adiabatic invariants.

The University Appointments Board has presented the annual report reviewing the work during the past year of the Board and the present position of the labour market as it affects students who have finished their university courses. It is stated that there are many opportunities available for men with a knowledge of both chemistry and engineering; another point of importance is that there is a lack of candidates for good appointments on the educational side in the Dominions.

LONDON.—The title of professor of physiology in the University has been conferred on Dr. J. S. Edkins, in respect of the post held by him at Bedford College. During the War, Prof. Edkins was a member of the Physiology Committee of the Royal Society and of the Grain-Pest Committee, and he also acted as secretary of the Chemical Warfare Medical Committee (a joint committee of the War Office and Medical Research Council). Since October 1911 he has published a text-book on practical physiology (with Pembrey, Beddard, L. Hill, and McLeod) and papers on the physiological and histological effects of poisonous gases and vapours, on the effect of various gaseous reagents upon the flour moth (*Ephestia Kuhniella*) and other pests found in flour, and more recently on parasitic organisms in carnivores and on an organism normal to the human stomach.

OXFORD.—On March 9 the second annual report of the Committee of Management of the Lewis Evans Collection of Scientific Instruments was presented to Convocation. The report deals, in the first place, with the public opening of the collection on May 5, 1925, and then proceeds to record the work done on the structure of the Old Ashmolean Museum, which has resulted in the restoration of one of the features originally provided by Wren. The complete text of the mural inscription over the old Library door has now been recovered, and its restoration has been thereby rendered possible. A list is given of accessions during the past year, many of these are of great interest. They include an early example of a Sprengel mercury pump, a seventeenth-century pharmacy jar for the reconstruction of one of Mayow's experiments on respiration, and a copy of Lieut.-Col F. Pepys-Cockerell's well-known portrait of Samuel Pepys, F.R.S. A beginning has been made with the construction of models of obsolete instruments, notably the 'perspectograph' and bowl level designed by Wren for the rebuilding of London after the Great Fire. Prof. Jenkin has made a special study of the astrolabes in the collection, and has published an explanatory book. Many collections have been deposited on loan, among the contributors being New College, St. John's College, and the Curator of the Daubeny Laboratory at Magdalen College. The Library has been enriched by the accession of works by Elias Ashmole, given by his representative, Mr. Bernard Ashmole An account of the whole collection has been published by the Clarendon Press, under the title of "Historic Instruments for the Advancement of Science." At the conclusion of the report, the energetic Curator, Mr. R. T. Gunther, fellow of Magdalen College, directs attention to the need for service rooms and accommodation for office work in the Ashmolean Building itself, the deficiency being at present supplied by the provision of part use of the Curator's private study at Folly Bridge.

SHEFFIELD —The Council of the University has decided to confer the title of honorary professor of mining on Mr. Douglas Hay, formerly professor of mining.

The following appointments have been made: Dr. D. C Harrison to a lectureship in pharmacology; Mr H. Blacow Yates to a part-time demonstratorship in anatomy; Mr. R. A. Mott to the post of research assistant in fuel.

THE doctorates conferred in the sciences by American universities have increased in number sixfold during the past twenty-five years, the number conferred in 1900 and 1925 being 102 and 621 respectively The Research Information Service of the National Research Council has compiled annually since 1919–20 a classified list of the theses of the recipients of these degrees and a statistical analysis by university and by subject is published in *Science* of December 25, 1925, with an announcement that statistics regarding the doctorates in chemistry and a list of dissertations covering the period 1922–23 to 1924–25 will appear in the *Journal of Chemical Education*. The list of the theses is on file in the Research Information Service, and information regarding them will be furnished on request. Of the 621 doctorates conferred in the sciences in 1925, no less than 244 are classified under the head of chemistry. Zoology and botany come next with 71 and 65 respectively. These three with physics (56) and psychology (51) include more than three-fourths of the total number of doctorates, the remainder being distributed among geology (25), mathematics (22), bacteriology (20), physiology (17), agriculture (13), geography (13), and eight other sciences (24). The number of doctorates conferred in mathematics has decreased noticeably since the War years, whereas almost every other subject shows an increase. Of the seven hundred and odd degree-conferring institutions in the United States, only forty-one conferred the doctorate in science in 1925, and of these, Wisconsin, Chicago, and Columbia head the list with 64, 59, and 51 respectively. Harvard conferred only 25.

Contemporary Birthdays.

March 21, 1861. Sir George Hadcock, K.B.E., F.R.S.
March 21, 1873. Dr. Andrew Balfour.
March 21, 1865. Right Hon. Herbert A. L. Fisher, F.R.S.
March 22, 1868. Dr. Robert A. Millikan.
March 25, 1863. Dr. Simon Flexner, For.Mem.R.S.

Sir GEORGE HADCOCK, formerly an officer in the Royal Artillery, is managing director of Sir W. G. Armstrong, Whitworth and Co., Ltd. He is an associate member of the Ordnance Committee. Sir George has written much on modern artillery developments. He is Hon.D.Sc. (Durham).

Dr. ANDREW BALFOUR was born at Edinburgh and educated at George Watson's College, and at the Universities of Edinburgh, Cambridge, and Strasbourg. He was Director of the Wellcome Tropical Research Laboratories, Khartoum, 1902–13, and for most of that period Medical Officer of Health, Khartoum. In 1918 he was president of the Egyptian Public Health Commission. Dr. Balfour is Director of the London School of Hygiene and Tropical Medicine.

Mr. FISHER is a Londoner, and was educated at Winchester, New College, Oxford, and at Paris and Göttingen. He was Vice-Chancellor of the University of Sheffield, 1912–16; then he became President of the Board of Education, holding office until 1922. In 1925 he was designated Warden of New College, Oxford. He is also a trustee of the British Museum. Mr. Fisher delivered the Lowell lectures at Boston, Mass., in 1909 and 1924. He was a member of the Royal Commission on the Public Services of India, 1912–15.

Dr. MILLIKAN, Director of the Norman Bridge Laboratory of Physics, Pasadena, California, was born at Morrison, Illinois, U.S.A. He graduated at Oberlin College, Ohio, and for two years afterwards taught elementary physics there; later on he occupied the chair of physics in the University of Chicago. He was Nobel laureate in 1923. Dr. Millikan's researches in the fields of electricity, optics, and molecular physics have been of outstanding importance. Most notable was the measurement of the charge of the electron. It was recorded that "this work furnishes the most direct and complete demonstration which has yet been found of the atomic structure of electricity." Recently he has announced the discovery of high-frequency radiation of cosmic origin. Dr. Millikan was Hughes medallist of the Royal Society in 1923. He is the author of "Science and Life" (1923).

Dr. SIMON FLEXNER was born at Louisville, Kentucky, and took his doctorate in medicine at the university of that city in 1889. He studied also at Johns Hopkins University, and at the Universities of Berlin, Prague, Strasbourg, and Paris. At the first-named he was professor of pathological anatomy, 1889–99, afterwards occupying a similar chair at the University of Pennsylvania until 1903, leaving to become Director of the Laboratories of the Rockefeller Institute for Medical Research, New York. He is an Officer of the Legion of Honour of France, Hon.LL.D., Cambridge, and D.Sc., Harvard, Yale, and Princeton Universities. Dr. Flexner is the author of many papers and monographs relating to bacterial and pathological subjects, including "The Bio-chemical Constitution of Snake Venoms"; "Epidemic Cerebrospinal Meningitis and its Serum Treatment"; "Experimental Epidemiology."

Societies and Academies.

LONDON.

Royal Society, March 11.—**J. A. Campbell**: The effects of ultra-violet radiation upon the metabolism of healthy subjects. Radiation by total rays (223 $\mu\mu$–770 $\mu\mu$) from the mercury-vapour lamp, or by the group of rays through blue uviol glass (290 $\mu\mu$–436 $\mu\mu$), or by the visible rays from either of these sources (400 $\mu\mu$–770 $\mu\mu$ and 400 $\mu\mu$–436 $\mu\mu$ respectively) has no effect upon the metabolism of healthy men, mice, or rats. When mice lie together in groups there is apparently a decrease of carbon dioxide output due to reduction of surface area. A simple method of estimation of carbon dioxide output and oxygen intake in small animals is described.—**E. Ponder**: A study of certain forms of inhibition and acceleration of hæmolysis. Four types are recognised: (1) the inhibition produced by plasma and serum, described by expressions which suggest an interaction between the plasma or serum and the lysis not unlike those which occur in adsorption processes; (2) the inhibition produced by certain bases, sugars, and neutral salts, which are described by linear expressions; (3) the acceleration produced by acids and by certain salts, also described by linear expressions; and (4) the acceleration produced by plasma or serum when added to a hæmolytic system in which the lysis is one of the bile salts or soaps. Types (2) and (3) are the most generally met with, and the expressions necessary for their description are given, the object of the study being to investigate the kinetics of such hæmolytic systems. In the case of substances the reaction of which is not neutral, the effect is not wholly dependent on the *p*H.—**S. B. Schryver** and **H. W. Buston**: The isolation of some undescribed products of hydrolysis of proteins. From the hydrolysis products of one of the oat proteins, two hitherto undescribed amino-acids were isolated by the authors' 'carbamate method' and were found in the non-basic fraction of the soluble barium carbamates. These latter can, by means of the zinc salts, be separated into three main fractions, one of which contained two amino-acids. These were separated by taking advantage of the fact that one gave a copper salt insoluble in methyl alcohol and the other a copper salt soluble in this solvent. The former has a formula corresponding with hydroxyaminobutyric acid, $C_4H_9O_3N$, and gave a dibenzoyl compound, m.p. 112°, and a phenylisocyanate compound, m.p. 143°. The other amino-acid has a formula corresponding with hydroxyvaline, $C_5H_{11}O_3N$, and gave a dibenzoyl compound, m.p. 117°, and a phenylisocyanate compound, m.p. 145°. There is evidence of the presence of other undescribed substances.—**A. W. Greenwood** and **F. A. E. Crew**: Studies on the relation of gonadic structure to plumage characterisation in the domestic fowl. Into a brown leghorn hen, ovariotomised when four days old, the testes of a brother were implanted. The bird first assumed the plumage characterisation of the cock, but after a general moult its plumage became as that of a hen. Post-mortem examination revealed a small fragment of degenerate ovarian tissue left behind at the time of operation, an active right gonad of testicular structure, and abundant testicular tissue which had developed from the grafts. Ovarian and testicular tissues in respect of their own individuation seem to exert demands upon the general economy of the same kind but different in degree; the functioning of an ovary is physiologically more expensive, but it is possible to augment the demands of the testes until they become equivalent to the ovary. This hen became cocky-feathered because in her body at this time there was active testicular tissue; later she became henny-feathered because the amount of testicular tissue had become greatly increased and had exerted demands upon the body equivalent to those of an active ovary.—E. P. **Cathcart** and W. A. **Burnett**: The influence of muscle work on metabolism in varying conditions of diet. A long series of muscle-work experiments were carried out on a human subject living on different types of diet: (1), low nitrogen, meat-free; (2), high nitrogen, meat-free; (3), as in (1), but meat extractives added; and (4), a meat-containing diet. The nitrogen exchange and the respiratory exchange were both studied. A definite rise in both the output of nitrogen and sulphur resulted from muscle work. Only a slight disturbance in the distribution of the nitrogen-containing constituents in the urine was noted. The consumption of oxygen seemed to be dependent to some extent on the nature of the food consumed.—E. **Fischer**: The heat liberated by the beating heart.

Royal Meteorological Society, February 17.—T. H. **Somervell**: On temperature at high altitudes: meteorological observations of the Mount Everest Expedition, 1924. The performance of any little extra work, such as even the recording of a temperature, is very irksome at high altitudes. Temperatures were usually recorded at 8.30h., 12h., and 16h. each day, and readings were taken from a minimum thermometer freely exposed to the sky about one foot above the ground. The lowest temperature recorded from this freely exposed thermometer was at Camp 3 (21,000 ft.), the reading being −24° F. Only a few observations were taken at Camp 4 (23,000 ft.) towards the close of the expedition.—F. J. W. **Whipple**: The significance of the observations (above), and particularly the lapse rate of temperature with respect to height.—Vaughan **Cornish**: Observations of wind, wave, and swell on the North Atlantic Ocean. The speed of the waves measured directly by the time taken to run the length of the ship, and the period as measured by the intervals between their arrival, gives an observed speed in agreement with that calculated from the period by the usual mathematical formula. Using a new and speedy method for determining the period of waves at sea which permits the separation of the wave proper from the swell, it was found that when there was no crossing swell, the speed of the waves was so nearly equal to that of the wind that their crests were travelling in almost calm air. When there was a crossing swell, the wind was unable to produce waves travelling with nearly its own speed, the deficiency being increased when the crossing swell was not from a following but opposing direction. The height of the waves was also kept down by crossing swell; this leads to an underestimate of the force of the wind as entered in the ship's log. The direction of the wind is more reliably recorded by the general run of the waves.—L. G. **Garbett**: Admiral Sir Francis Beaufort and the Beaufort Scales of Wind and Weather.—Admiral Sir Francis Beaufort was for twenty-six years Hydrographer of the Navy. Extracts from Beaufort's private logs show the interest he took in the study of the weather. The Beaufort scales were devised in 1806 by Beaufort when in command of H.M.S. *Woolwich*, but were not introduced into the Navy until 1838, and then in a form somewhat modified from the original.—J. **Bartels**: On the determination of minute periodic variations. A method is described for obtaining the best possible values for amplitude and phase of a periodicity of given length, if the period is hidden by comparatively large irregular fluctuations. The scheme is applied to the determination of the lunar diurnal variation of atmospheric pressure in higher latitudes.

Linnean Society, February 18.—C. C. A. **Monro**: Polychæta of the *Alert* Expedition: families Hesionidæ and Nereidæ. This paper is the last of the series containing a systematic account of the Polychæta collected by H.M.S. *Alert* during her voyage in 1881–82. It is an account of the families Hesionidæ and Nereidæ and attempts to place the classification of the genus Hesione on a more satisfactory basis. All the examples are from the Indo-Pacific area.—J. **Ramsbottom**: "Fairy rings" in air-photographs.—F. O. **Bower**: A scheme of phyletic grouping of ferns. In "The Ferns," vol. 1., an analysis has been given of those criteria of comparison of the ferns which may be used with the view of their phyletic grouping. These have been arranged under twelve heads. An 'archetype' for the class would seem to be substantially similar to plants which were actually living in the Devonian period, namely the Psilophytales. It would consist of a simple upright shoot of radial symmetry, possibly rootless, dichotomising if it branched at all, and with the distinction between axis and leaf ill-defined. The whole plant would be relatively robust as regards cellular construction, and traversed by conducting strands with a solid xylem-core. The solitary sporangia would be relatively large and distal in position, with thick walls and a simple method of dehiscence, and each would contain numerous homosporous spores. Vol. 2 of "The Ferns," now passing through the press, is devoted to those ferns which both comparison and palæontology indicate as relatively primitive. They include all the eusporangiate ferns, together with certain families which have archaic features. The eusporangiate and leptosporangiate types, with intermediate types, are Simplices, and all date back to Mesozoic or even to Palæozoic time. Their existence makes it appear probable that in the course of descent a gradual transition took place from the eusporangiate to the leptosporangiate state. In vol. 3 of "The Ferns" an attempt will be made to trace the phyletic relationships between the various groups.

Faraday Society, February 22.—A. J. **Allmand** and R. H. D. **Barklie**: The influence of alternating currents in the electrolytic corrosion of iron. The corrosion of iron in alkaline solutions by direct current, alternating current, and by alternating current superposed on direct current has been investigated. The superposition of the two types of current causes relatively increased corrosion. A similar result has been found when using typical subsoil drainage liquid saturated with carbon dioxide. Experiments have also been carried out on the accelerating effects of added alkaline chloride on corrosion in alkaline solutions.—A. N. **Campbell**: The direct oxidation of manganous ion to permanganate. The conditions under which manganous ion can be anodically oxidised to permanganate have been studied, and the optimum conditions evaluated. Only permanganate is produced by this oxidation.—H. J. **Poole**: The elasticity of jellies of cellulose acetate in relation to their physical structure and chemical equilibria. The load-strain curve for cellulose acetate jellies bends continuously towards the load axis, suggesting a sponge-like or fibrillary structure of rigid material in the jelly. The elasticity in a solvent consisting of benzyl alcohol and water in constant ratio follows approximately the square of the concentration. Thus the material of the rigid phase exists as a result of a dynamic solvation equilibrium between the cellulose acetate and the solvent. Permanent deformation was not induced by heating and cooling temporarily deformed specimens, so the structure first formed on gelation is mainly of a permanent nature. Equilibrium in elastic properties was only reached after a considerable period following a change in temperature. The creep under stress was studied and a coefficient of inner resistance proposed. Values of this coefficient run parallel with the viscosity of the parent sols. Benzyl alcohol as a solvent is deficient in OH groups Partial replacement of benzyl alcohol by water resulted in a decrease in elasticity and an increase in solvation. On the other hand, partial replacement by xylene resulted in an increase in elasticity and a decrease in solvation.—**F. G. Tryhorn** and **W. F. Wyatt**: (1) The adsorption by a coconut charcoal of saturated vapours of some pure liquid. The adsorptive power at 20° C. of a purified coconut charcoal has been determined for fourteen liquids. The initial rate of adsorption, in accordance with the laws of diffusion, is proportional to the vapour pressure of the liquid, and inversely proportional to the square root of its molecular weight. For eleven of the liquids the velocity of adsorption is a discontinuous function of time. The discontinuities may correspond with the sudden formation of a liquid surface in the charcoal. (2) Stages in the adsorption by a coconut charcoal from vapour mixtures of alcohol and benzene and of acetone and benzene The adsorption curves consist of three parts. The first stage is adsorption of the two components in a constant ratio. When the density of the adsorbed vapour exceeds a certain value, condensation to a liquid occurs in the charcoal. This marks the second stage, which continues until the liquid phase is in equilibrium with the bulk liquid With the charcoal employed, this change occurred without further increase in the total number of moles adsorbed, and in every case involved displacement of alcohol or acetone by benzene. The difference between the compositions of the adsorbed liquid phase and of the bulk liquid is attributed to selective adsorption. The third stage of the adsorption process is one of isothermal distillation of the bulk liquid into the intergranular spaces of the charcoal, and is the result of the curvature of the liquid surfaces at the points of contact of the grains.—**I. R. McHaffie**. A device for circulating fluids under high pressure. This is essentially an electro-magnetically operated pump which by a suitable arrangement of valves produces a constant flow of gas in the desired direction. It has been used continuously for the circulation of air at pressures up to 100 atmospheres.

DUBLIN.

Royal Dublin Society, February 23.—**W. E. Adeney** and **Miss B. B. Dawson**: The estimation of organic matter in water by means of potassium bichromate and sulphuric acid. These reagents are used for the estimation of small quantities of oxidisable matter in water; the method is especially valuable for dealing with sewage liquors.—**T. G. Mason** and **C. J. Lewin**: On the rate of carbohydrate transport in the greater yam, *Dioscorea alata* Linn. Experiments carried out on a large scale in southern Nigeria proved that the average increase of tuber dry weight per stem amounted to 45 gm. a week during the period of maximum growth. Assuming the concentration of carbohydrates in the sieve tubes to be 25 per cent, this would represent a velocity of 88 cm. per hour. A movement at this rate through the sieve tubes being clearly impossible, it is concluded that, even if high concentrations are assumed, the phloem is incapable of transmitting the main flow of carbohydrate.—**J. Reilly**, **P. J. Drumm**, and **C. Boyle**: The production of lavender oil from Irish-grown plants. Preliminary experiments on the production of lavender oil from Irish-grown plants have yielded promising results. Further work on a larger scale is in progress. The possibility of the economic production of high-grade lavender oil in Ireland is considered.

EDINBURGH.

Royal Society, February 22.—**Rev. T Crouther Gordon**: The finding of the Galilee skull. An excavating expedition was organised in the spring of 1925 by the British School of Archæology in Jerusalem, to examine some caves in Wadi 'Amud in Galilee. In the largest cave there were 110 cm. of stratified deposits on the floor, and below this a petrified layer of prehistoric flints All the historic periods were represented by the 28 strata Beneath two large stones in the Palæolithic level the frontal bone of a human skull was found, along with the malar bone, and the right half of the sphenoid bone, completely petrified. The pronounced supra-orbital ridges mark it as distinctly Neanderthal in type, and the associated flints testify to the same culture. It is the first trace of the Mousterian type of man outside of Europe.

MANCHESTER.

Literary and Philosophical Society, February 23 — **T. A. Coward**: (1) The vertebrates of the Manchester district; a contribution to the regional survey. There are moorland, foothill, lowland, mossland, and urban faunas. The true moorland fauna has, perhaps, the most exclusive character; it is confined to the higher hills to the north and east of Manchester, typical grouse-moors with spongy mosses and rocky outcrops. The foothill and lowland faunas have much in common, though certain animals are typical of each. The foothills lie south and west of the moors; the lowlands, partly agricultural, partly suburban, extend farther to the south and west, and contain many parks, woodlands, and lakes or meres inhabited by animals which are mainly characteristic of these environments. The mosslands are, or were, in the river valleys, and are in a transition stage, drainage and cultivation and the growth of residential areas constantly altering the character of the fauna. The urban fauna is that which is restricted by the populated areas, and it too suffers change through increase in population, but is recovering some of its former character under the influence of municipal protection and the provision of open spaces and parks. (2) The vertebrates of the Shetland Isles. Certain of the characters of the fauna are due to latitude and isolation. Terrestrial mammals are few, and one at least, the wood-mouse, is an insular form, having much in common with the mouse of the Faeroes; other animals owe their status to introduction rather than survival. Although there is a large passage avifauna, resident birds are not numerous in species though abundant in individuals; most of them have a marine life. Two of the resident passerine birds are insular forms, and others are of a northern type. Cetaceans and pinnipedes are more numerous than in any other part of the British Islands The fish, except for migratory species like the herring, are of northern type. Thanks to protection, the birds are rapidly increasing in numbers, but other factors influence the spread and colonisation of the fulmar, gannet, and perhaps one or two other species.

PARIS.

Academy of Sciences, February 22.—**A. Lacroix**: A new eruption of the volcano of Reunion (December 30-31, 1925). This eruption took the same form as that of September 12, 1924, and the lava is flowing in the same direction.—M. Georges Perrier was elected a member of the section of geography and navigation in succession to the late L. Gentil.—B. **Hostinsky**: The transformation of differential expressions.—N. **Saltykow**: The general integral of characteristics.—Paul **Lévy**: A theory of growth.—N. **Boneff**: The origin of satellites.—Thadée **Pecsalski**: The crystallisation and sublimation of the metals. Continuing previous experiments on the cementation of metals by salts, experimental proof is given of the sublimation of metals in contact with their salts, the vapours of the metals arising from the reduction of the chlorides.—**Michel-Samson**: The change of the coefficient of expansion of substances in the amorphous state. Experiments on silicates, borates and phosphates described in an earlier communication have been extended to amorphous organic substances. From the experiments detailed it is concluded that all bodies in the amorphous state show a discontinuity in the coefficient of expansion for a viscosity of the order of 10^{14} poises. To this discontinuity there corresponds a change in all the physical properties. In the case of the silicates this anomaly has been attributed to a change in the allotropic state of the silica. It is, however, a general property of matter.—Jean A. **Athanasiu**: The use of mixtures of water and alcohol in the electrometric study of reactions by precipitation. An enumeration of the advantages presented by the use of aqueous alcohol (30 per cent.) in place of water in some electrometric estimations of cerium, barium, mercury and lead.—S. **Glixelli** and Mlle. **Deniszczukowna**: The preparation and properties of solutions of antimonic acid.—Albert **Portevin**: The fringes due to cold hardening or corrosion. An account of the superficial deformations of the crystalline grains produced by polishing and of the effects shown after etching.—André **Kling** and Daniel **Florentin**: The hydrogenation of organic substances at a high temperature and under high pressures in the presence of non-hydrogenating catalysts. It was to be supposed that the addition of catalysts would lower the temperature at which hydrogenation under pressure takes place, and this has been confirmed by experiment. The examples given include the production of cyclohexane and normal hexane from cyclohexanol in the presence of alumina, and of benzene, toluene, xylene, etc., from naphthalene in the presence of ferric or aluminium chloride.—**Pastureau** and **Bader**: The chlorhydrins of some unsaturated $\alpha\beta$-ketones.—Albert **Michel-Lévy**: Crushed zones and mylonites later than the Stephanian in the crystalline Maures massif.—P. **Corbin** and N. **Oulianoff**: The chain of the Aiguilles Rouges in the alpine orogenic movement.—Casimir **Rouppert**: Benzidine as a reagent in living plants. An account of results obtained by the culture of the bean in weak benzidine solutions.—O. **Munerati**: The possibility of determining the age of grains of wheat by the temperature of their germination. From a study of the manner in which the seeds germinate when exposed at temperatures varying from 32° C. to 6° C., the age of the seeds, if collected within three years, can be accurately judged. It follows from this that the optimum germination temperature of seeds, at least so far as concerns cereals, is a function of the age of the seed.—Mlle. Panca **Eftimiou**: Nuclear evolution in the Exoasceæ.—Davy de **Virville**: The action of the subterranean medium on the mosses.—L. **Lavauden**: The presence of a cypress in the mountains of Tassili des Azdjers (Central Sahara).—Jules **Amar**: Growth and alimentary interactions.—L. **Fournier** and A. **Schwartz**: The preventive action of bismuth in experimental syphilis of the rabbit.

Official Publications Received.

Agricultural Experiment Station of the Rhode Island State College. Bulletin 202: Field Observations and Laboratory Findings in Paralysis of the Domestic Fowl. By Henry G. May, Ralph P. Tittsler and Kenneth Goodner. Pp. 20. (Kingston, R.I.)

Report of the Botanical Survey of India for 1924–25. Pp. 10. (Calcutta.)

New Zealand: Department of Lands and Survey. Annual Report on Surveys. Pp. 10. (Wellington, N.Z.: W. A. G. Skinner.) 6d.

Dominion of **New Zealand**: Department of Lands and Survey. Surveys and Maps: an Exposition of the Work, Methods and Organisation of the New Zealand Survey. Special Publication for Distribution at the New Zealand and South Seas Exhibition, Dunedin, 1925–26. Pp. 24. (Wellington, N.Z.: W. A. G. Skinner.)

Bureau of Education, India. Education in India in 1922–24. Pp. iv+78. (Calcutta: Government of India Central Publication Branch.) 14 annas; 1s. 6d.

University of California Publications. Publications of the Lick Observatory, Vol. 15: Meridian Circle Observations made at the Lick Observatory, University of California, 1904–1924. By Richard Hawley Tucker. Pp. 262. (Berkeley, Calif.)

Smithsonian Miscellaneous Collections. Vol. 73, No. 3: Opinions rendered by the International Commission on Zoological Nomenclature. Opinions 82 to 90. (Publication 2830.) Pp. 40. (Washington, D.C.: Smithsonian Institution.)

Report of the Secretary of the Smithsonian Institution for the Year ending June 30, 1925. (Publication 2834.) Pp. vi+122. (Washington, D.C.: Government Printing Office.)

Annual Report of the Director, United States Coast and Geodetic Survey, to the Secretary of Commerce for the Fiscal Year ended June 30, 1925. Pp. iv+79+23 plates. (Washington, D.C.: Government Printing Office.) 50 cents.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 8: Het Klimaat van Nederlandsch-Indie (The Climate of the Netherlands Indies). Door (by) Dr. C. Braak. Deel 2 (Vol. 2), Aflevering 1 (Part 1): Sumatra. (With English Summary.) Pp. v+156+67. Verhandelingen No. 17: Diepteloodingen in den Indischen Archipel (Depth Soundings in the East Indian Archipelago). Aflevering 1 (Part 1). Pp. 16. (Batavia: Typ. Javasche Boekhandel en Drukkerij.)

Field Museum of Natural History. Zoological Series, Vol. 15: The Marine Fishes of Panama. By Seth E. Meek and Samuel F. Hildebrand. Part 2. (Publication No. 226.) Pp. vii+331-707+plates 25-71. Museum Technique Series, No. 1: Herbarium Organization. By Charles F. Millspaugh. Pp. 18. (Chicago, Ill.)

Aeronautical Research Committee. Reports and Memoranda, No. 982 (M. 30): High-Frequency Fatigue Tests. By Prof. C. F. Jenkin. (M.C. 140.) Pp. 24. 9d. net. Reports and Memoranda, No. 983 (Ae. 196): A Comparison of Model and Full Scale Performance of the Bristol Fighter using Flight Lieut. Capon's Method of Presentation. (A. 3 k. Misc. Model Expts., 50. A.4.b. Full Scale Work—Aeroplanes General, 126 (T. 2106).) Pp. 3+2 plates. 4d. net. (London: H.M. Stationery Office.)

Philosophical Transactions of the Royal Society of London. Series B. 415, Vol. 214: On a new Type of Crustacean from the Old Red Sandstone (Rhynie Chert Bed, Aberdeenshire)—*Lepidocaris rhyniensis*, gen. et sp. nov. By D. J. Scourfield. Pp. 153-187+plates 21-23. (London: Harrison and Sons, Ltd.)

Smithsonian Miscellaneous Collections. Vol. 77, No. 9: Fossil Footprints from the Grand Canyon. By Charles W. Gilmore. (Publication 2831.) Pp. 41+12 plates. (Washington, D.C.: Smithsonian Institution.)

Reprint and Circular Series of the Bureau of Standards. No. 63: Second Census of Graduate Research Students in Chemistry. By James F. Norris. Pp. 14. 15 cents. No. 64: International Biology; an Address prepared for the Third Pan-American Scientific Congress, held at Lima, Peru, December 20, 1924–January 6, 1925. Pp. 11. 15 cents. No. 65: The Vital Need for greater Financial Support of Pure Science Research; an Address presented upon the Henry Robinson Towney Lectureship before the American Society of Mechanical Engineers, New York City, December 1, 1925. By Herbert Hoover. Pp. 6. 20 cents. (Washington, D.C.)

Agricultural Research Institute, Pusa. Bulletin No. 162: Tentative Keys to the Orders and Families of Indian Insects. By T. Bainbrigge Fletcher. Pp. iv+101+9 plates. (Calcutta: Government of India Central Publication Branch.) 1.4 rupees; 2s. 3d.

Conseil Permanent International pour l'Exploration de la Mer. Rédigé par Dr. E. S. Russell. Vol. 1, No. 1. Pp. 96. (Copenhague: Andr. Fred. Høst et fils.) 4.50 kr.

The Rockefeller Foundation: International Health Board. Eleventh Annual Report, January 1, 1924–December 31, 1924. Pp. xviii+179. (New York City.)

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 25: Constructive Tendencies in Rural Education. By Katherine M. Cook. Pp. 27. 5 cents. Bulletin, 1925, No. 34: Educational Boards and Foundations, 1922–1924. By Henry R. Evans. Pp. 12. 5 cents. (Washington, D.C.: Government Printing Office.)

United States Department of Agriculture. Department Bulletin No. 1371: Effectiveness against the San Jose Scale of the Dry Substitutes for Liquid Lime-Sulphur. By W. S. Abbott, Julian L. Culver and W. J. Morgan. Pp. 26. (Washington, D.C.: Government Printing Office.) 5 cents.

Dominion of Canada: Department of Agriculture. Bulletin No. 58, New Series: A Survey of Canadian Plants in relation to their Environment. By J. Adams. Pp. 60. (Ottawa: F. A. Acland.)

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Extracted from Year Book No. 24, for the Year 1925.) Pp. 171-190. (Washington, D.C.)

University of London: University College. Report of the University College Committee (February 1925–February 1926), with Financial Statements (for the Session 1924–25), and other Documents, for Presentation to the Senate. Pp. 106. (London: University College.)

Diary of Societies.

SATURDAY, March 20.

British Mycological Society (at Lister Institute), at 11 A.M.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: The Rare Gases of the Atmosphere and their Importance in Atomic Theory (3).

Institute of British Foundrymen (Lancashire Branch, Junior Section) (at Manchester College of Technology), at 7.—A Hodgkinson: A General Talk on Foundry Work.

Hull Association of Engineers (at Hull Technical College), at 7.15.—W A. Jackson Machinery and Plant Maintenance in the Textile Trade.

Physiological Society (at University College).

MONDAY, March 22.

Royal College of Surgeons of England, at 5.—Mr. Shattock: Demonstration of Specimens of Surgical Affections of the Kidneys.

Institution of Electrical Engineers (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—L. C Grant: Developments in High Power Fuses.

Royal Society of Medicine (Odontology Section), at 7.30—F N. Doubleday: Demonstration of Blood Films and Kiamographic Records of Hearts—At 8—F. N. Doubleday: Action of Local Anæsthetic Solutions on Living Cells

Aristotelian Society (at University of London Club), at 8—J Levine: Naturalism and Values.

Royal Society of Arts, at 8—W. F. Higgins: Thermometry (Cantor Lectures) (2)

Royal Geographical Society (at Æolian Hall), at 8.30

Medical Society of London, at 8.30—Prof Blair Bell. The Use of Lead in the Treatment of Malignant Disease.

TUESDAY, March 23.

Royal Dublin Society, at 4 15.—Prof. W. E. Adeney: On the Rate and Mechanism of the Aeration of Water under Open Air Conditions.—J. Bell: The Constitution of Dicyano Diamide with a Note on the Formation of a Mercury Derivative—Prof. J. Doyle and Miss P. Clinch: The Pentoran Theory of Cold Resistance applied to Conifers.

Royal College of Physicians of London, at 5.—Sir Thomas Horder, Bart Endocarditis (Lumleian Lectures) (1)

Royal Institution of Great Britain, at 5.15.—Prof. C. H. Desch: The Growth of Crystals (2).

Institution of Petroleum Technologists (at Royal Society of Arts) (Annual Meeting), at 5.30.—Sir Thomas H. Holland: Presidential Address.—Discussion on paper by Dr. Wade on The Search for Oil in Australia.

Zoological Society of London, at 5 30.—Secretary: Report on the Additions to the Society's Menagerie during the month of February 1926—J Omer-Cooper: A Revision of the Genus Periscyphis Gerst. (*Isopoda Terrestria*)—B. N. Schwanwitsch: On the Modes of Evolution of the Wing-pattern in Nymphalids and certain other Families of Rhopalocerous Lepidoptera.—R I Pocock: (a) The External Characters of the Jamaican Hutia (*Capromys brownii*); (b) The External Characters of the Flying Lemur (*Galeopterus temminckii*).

Manchester Literary and Philosophical Society, at 5.30.—Prof A Sommerfeld: The Periodic System, Chemical Bonds, and Crystal Structure.

Institute of Marine Engineers, at 6.30.—D. Brownlie: Super-Pressure Steam Generation.

Institution of Electrical Engineers (East Midland Sub-Centre) (at University College, Nottingham), at 6.45—C. C. Sutton and J. H. R. Nixon. Power Factor.

Institution of Automobile Engineers (at 83 Pall Mall), at 7.—Prof J. J. Guest: The Main Free Vibrations of an Autocar.

Society of Chemical Industry (Glasgow Section), at 7.—R. Maclaurin: Causes of Reactivity and Inactivity in Cokes

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—J. W. J. Townley: The Operation of a Modern Power Station.

Royal Photographic Society, at 7—B Park: A Glimpse of Corsica l'île parfumée

Institution of Engineers and Shipbuilders in Scotland (at 39 Elmbank Crescent, Glasgow), at 7.30.

Institute of Chemistry (Edinburgh and East of Scotland Section) (and Society of Chemical Industry (Edinburgh and East of Scotland Section)) (at 36 York Place, Edinburgh), at 8.—Sir W. H. Perkin: The Early History of Ring Closure.

WEDNESDAY, March 24.

Society of Chemical Industry (Chemical Engineering Group) (at Chemical Society), at 3 and 6.—Symposium on Bearings and Lubricants:—R. Amberton: Roller Bearings.—R Allan: Ball and Roller Bearings. Characteristics affecting their Practical Application and Use—Dr. A. E. Dunstan and R W L. Clarke: The General Properties of Lubricating Oils and their Practical Application.—J H. Hackford. Some Characteristics of Lubricating Oils

Institute of Hygiene, at 3.30.—Lieut.-Col R. H Elliot. Eye Troubles of School Life.

Royal Society of Medicine (Comparative Medicine Section) (jointly with Electro-Therapeutics Section), at 5.—Dr. J. F. Halls Dally: Ultra-violet Radiation in Man.—E. Middleton Berry: The Therapeutic Effects of Ultra-violet Rays and High Frequency Currents in Animals—Prof Leonard Hill, Dr. Weinbein, Dr. H. Munro, H Stainton, and Dr. L. Dobson: Discussion on above.

Geological Society of London, at 5.30.—Sir T. W. Edgeworth David: The Physiography and Tectonic Structure of the Commonwealth of Australia (Lecture)

Radio Society of Great Britain (at Institution of Electrical Engineers), at 6—Prof. E. W Marchant. Fading (Lecture)

Royal Microscopical Society (Industrial Applications of the Microscope Section), at 7.30.—James Swift and Son, Ltd.: Exhibition of Prof. S J. Shand's Recording Micrometer and a Screw Measuring Microscope—R. and J. Beck, Ltd. Exhibition of (1) Proof Plates; (2) Lewbeck Micrometer; (3) Cobweb Micrometer; (4) Micrometer Eyepiece; and (5) Barnard's Interferometer Plates—At 8—W. H. Johnson: The Use of the Microscope as a Measuring Instrument.

THURSDAY, March 25.

Chemical Society (Annual General Meeting) (at Manchester University), at 4.—Dr. A. W. Crossley: Presidential Address

Royal Society, at 4 30—E B. Verney: The Secretion of Pituitrin in Mammals, as shown by Perfusion of the Isolated Kidney of the Dog.—H. W. Florey and H. M. Carleton: Rouget Cells and their Function.—*To be read in title only*—Seana King. Oogenesis in *Oniscus asellus*—R. M Sargent. The Relation between Oxygen Requirement and Speed in Running

Royal College of Physicians of London, at 5.—Sir Thomas Horder, Bart.: Endocarditis (Lumleian Lectures) (2)

Royal Institution of Great Britain, at 5 15—Prof. J. Holland Rose The Indecisiveness of Modern Warfare (2)

Royal Aeronautical Society (Students' Section), at 6.—S. S. Hall: Stalled Flying

British Astronomical Association (West of Scotland Branch) (at Royal Technical College, Glasgow), at 7 30.—Rev J. T. Bird: Austral Orientation, with Special Reference to the Calendar and to the Teaching of Geography.—Dr. G. D C Stokes: The Equation of Time.

Institute of Chemistry Students' Association (London), at 8—Debate.

Tuberculosis Society (jointly with Society of Superintendents of Tuberculosis Institutions) (at Cambridge)—Sir Humphry Rolleston, Sir St. Clair Thomson, Prof. E. Collis, Prof. L. Cummins, Dr. J. Crocket, and Dr G Marshall. Communications.—Demonstration by Dr H. De Carle Woodcock: Apparatus for Artificial Pneumothorax—Dr. C. Riviere, Dr. V Pearson, M Davies, and Dr. P. Morgan: Discussion on the foregoing.

FRIDAY, March 26.

Electrical Association for Women (at Holophane, Ltd., Elverton Street, S.W.), at 3.—Scientific Illumination.

Physical Society of London (at Imperial College of Science and Technology), at 5.—L Backhurst: Obliquity Corrections in Radium Estimation.—Dr A. Griffiths and P. C Vincent: The Viscosity of Water at Low Rates of Flow, Determined Comparatively by a Method of Thermal Convection.—Dr. E. H. Rayner. Demonstration of Some Simple Experiments with Thermionic Valves.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Demonstration of Specimens of Spina Bifida and Allied Conditions.

Institution of Municipal and County Engineers (Metropolitan District Meeting), at 6.30.—J. Garvie: The Life of Wood Paving as affected by Expansion.

Institution of Mechanical Engineers, at 7.—S. Hunter and others: Discussion on 'Perlit' Iron.

Royal Photographic Society, at 7.—J. MacSymon: A Criticism of the 1925 Competition Prints.

Royal Sanitary Institute (at Guildhall, Derby), at 7.—Dr. P. Turton, Dr. E. Milligan, and others. Discussion on Goitre.—C A Clews and others: Discussion on Some Aspects of the Housing Problem.

Manchester Association of Engineers (at Engineers' Club, Manchester), at 7.15.—P W Seemer: Hydro-electric Engineering

Junior Institution of Engineers, at 7.30.—A. B Miller: Metal Aeroplane Construction.

Royal Institution of Great Britain, at 9.—Sir Ernest Rutherford: The Radiation from Atomic Nuclei.

Society of Chemical Industry (Chemical Engineering Group).—Symposium on Bearings and Lubricants.

Manchester Literary and Philosophical Society.

Tuberculosis Society (jointly with Society of Superintendents of Tuberculosis Institutions) (at Cambridge) (Continuation.)

SATURDAY, March 27.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: The Rare Gases of the Atmosphere and their Importance in Atomic Theory (4)

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 3.—J. F. C. Friend: Winding Ropes.

Tuberculosis Society (jointly with Society of Superintendents of Tuberculosis Institutions) (at Cambridge). (Continuation.)

PUBLIC LECTURES.

SATURDAY, March 20.

Horniman Museum (Forest Hill), at 3.30.—C. Daryll Forde: Agriculture and the Origin of Civilisation.

MONDAY, March 22.

Maidstone.—Sir Wilfred Beveridge: Insects in Relation to Public Health (Chadwick Lecture).

THURSDAY, March 25.

Dyers' Hall (Dowgate Hill, E.C.), at 6.—Dr. H. Levinstein The Dyestuff Industry and the State.

SATURDAY, March 27.

Horniman Museum (Forest Hill), at 3.30.—Dr. H. S. Harrison: Early Man and his Wanderings.

CONGRESS.

April 2 to 23.

Jerusalem and Beirut, International Archæological Congress.

SATURDAY, MARCH 27, 1926.

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The Electricity Supply Bill.

THE Electricity Supply Bill, the text of which has now been published, contains no surprises. The framers of the Bill have kept two eminently desirable objects in view, namely, the utilisation to the best advantage of the heat generated by the combustion of coal and the cheapening of the supply of electrical energy in Great Britain for lighting and power to the consumer. The project if carried out will increase the value of coal and will prevent its waste. A cheap supply of electrical power ought to enable many of our export industries to compete successfully in the world's markets. The project, therefore, is of national importance and ought to be discussed from a national point of view. In all problems of this nature, however, the 'human factor' has to be considered.

In the Bill, provision is made for the establishment of a Central Electricity Board which will consist of a chairman and seven other members. The main duty of this Board will be to supply electricity to authorised undertakers, but it will only generate electricity in exceptional cases. One of the first duties of this Board will be to submit to the Electricity Commissioners a scheme which will state what generating stations, existing or to be built, will be 'selected stations' for supplying electricity for the purposes of the Board. The Board is to provide for interconnexion of selected stations and authorised undertakings by means of main transmission lines which it will purchase or construct. It will also take means to standardise the frequency of the alternating current supply.

When the scheme is completed it will be published, and all persons interested in it can then be heard. The owners of supply stations affected have the right of appeal to the Electricity Commissioners, who have won golden opinions from every one in the past by the fairness and judicial calmness they have displayed when adjudicating on contentious matters. In the event of the owners and the Board failing to agree, the Board will have the right to acquire the undertaking. If no suitable authority be found willing to operate it, then the Board itself can make arrangements for carrying on the work.

The owners of selected stations are to operate as the Board may direct and are to sell to the Board on specified terms. The Board has to construct and lay down the mains and transmission lines which are requisite for purposes of interconnexion. It has also to supply the authorised undertakings at a price fixed so that the receipts may cover the expenditure when taken over a number of years. The tariff will be a 'John Hopkinson' tariff, consisting of two parts, a fixed charge and a charge depending on the load. If any authorised undertaking refuses to accept the Board's terms, then the Board has power to compel the undertaking to supply the consumer at the same rate as if it purchased its supply from the Board.

Roughly speaking, the Government has in view the selection of several highly efficient large power stations which will supply over transmission lines, belonging to the Electricity Board, to industrial centres. The small generating stations in these centres which now convert the heat obtained from the combustion of coal into electricity with a low efficiency will cease to be generating stations and will become merely distributing centres.

In order that the distribution may be done economically, it is certain that very high voltage must be used. The fixing of this voltage will be one of the first duties of the Board. Probably 110,000 volts will be chosen for the pressure of transmission, and the system adopted will almost certainly be the three-phase system. Except in the proximity of towns, the three large copper or aluminium conductors will be suspended from lattice steel towers at a considerable height from the ground. These steel towers, with wires suspended between them, are not beautiful, but they will not spoil the landscape so much as railway lines do. They will take many months to complete, and so perhaps it is necessary to state that the public should not expect any immediate reduction in the price of electricity.

The success of the scheme depends largely on the constitution of the first Board. We hope that some of the members will be young electrical engineers who have had experience of high-tension work in other countries. One also should be an expert in underground cable work, with first-hand knowledge of the maximum electric pressures that can be used in underground work. The questions of the maximum economy of transmission which are essential to the success of the scheme can only be solved by advanced mathematics and engineering intuition. The latter is necessary, as unfortunately we cannot foretell what will be the best distributing points ten years hence. In engineering it is sometimes necessary to make rapid decisions on insufficient data and to move forward warily, always being ready to amend the scheme when unforeseen developments arise.

Luckily, most of our leading engineers are almost wholly engrossed by their work. They take pride not only in its excellence but also in the amount of work they can do. In this respect they are unlike their humbler brethren, who are sometimes dominated by their fellow-workmen so that they are afraid to do their best or work their hardest.

Difficulties common to every great scheme for improving industry will doubtless arise. Certain engineers will have their stations 'selected,' others equally capable will be left in the humbler ranks of the distributors. There are many capable electrical engineers who have been working for the last ten or twenty years converting unprofitable supply undertakings into profitable ones. They have laboured well and hard and have exercised thrift in every possible direction. Plant laid down twenty years ago is still in excellent working order, although naturally it is not nearly so efficient as large modern plant. Other stations are burdens either on the shareholders or the ratepayers. Engineers have scrapped plant from which they were unable to get the maximum output or make work economically. New plant has been purchased, the thermal efficiency of which may meet the approval of the Board. Our sympathies are, however, with the hardworking and thrifty engineer, who, although he has made a commercial success of his undertaking, will doubtless in the future be merely a 'distributor.' It is sometimes truer economy to buy a set of cheap engines to help carry the 'peak' load than to buy a large turbine, with all its auxiliary plant, before it is really needed.

The new era, however, will give rise to new problems. Although we sympathise with those capable engineers, the importance of whose positions will be injuriously affected by the Bill, yet this is the way of progress. The Ministry of Transport has a heavy responsibility in appointing the new Board. Engineers who are familiar with the much less important problems arising in town distribution may not be the right men to handle the much graver problems which this scheme proposes. It is certain that, whatever system is adopted, it will in time become antiquated. It is necessary, therefore, to keep an open mind and to modify the system whenever by any means, present or future, economies can be effected by so doing.

Climate and Man in the United States.

The Climates of the United States. By Prof. Robert DeCourcy Ward. Pp. xvi + 518. (Boston, New York and London: Ginn and Co., 1925.) 4 dollars.

IN this work, Prof. Ward, the well-known climatologist of Harvard, gives us not merely a compilation of statistics relating to the distribution of the meteorological elements over his country, but to a very considerable extent, also, he exercises the true function of the climatologist in presenting vivid descriptions of climate, and its effects upon economic status and national life. The twenty-three chapters of the book, abundantly illustrated with charts and curves, including a handsome map of mean annual rainfall, discuss historical matter, the geographical controls of climate, the different types of climate met with in the United States, the regional and seasonal distribution of all the chief elements, namely, pressure, wind, temperature, humidity, sunshine, rain, and snowfall, etc., together with the relation of climate to crops and of climate to health. Thunderstorms and tornadoes, hot and cold waves, which are all in their great intensity characteristic American weather phenomena, come in for special discussion, as also 'blizzards,' Chinook winds (the föhn of the Rockies), and that peculiar phase of autumnal weather known as the 'Indian summer'—the great beauty of which in the eastern States is expatiated upon.

The use of the plural form in the title will be observed in regard to an area which includes a 'Mediterranean' type of climate on the Pacific coast, an almost tropical type on the shores of the Gulf of Mexico, an arid type in the Great Basin, semi-arid in the Plains, an extreme continental type with intensely cold winters, somewhat modified near the Great Lakes, along the Canadian border, and an Atlantic coast type which so far resembles the Atlantic coast of Europe as to have variable weather and a well-distributed, abundant rainfall. It must not be imagined, indeed, that we in England have any monopoly of changeable weather, for in New England the vicissitudes, just as frequent, are far more severe, and the New Yorker in winter time must be prepared for a change, within forty-eight hours, of, say, from +65° F. to −10° F., the like of which the Londoner has never dreamed. It is a little inconsistent, perhaps, to find the outlying Arctic territory of Alaska accorded the entire concluding chapter, while Cuba and the Sandwich Islands, also politically American, receive no mention—even though the Philippines, which physically belong to Asia, might well be excluded by reason of distance. The intense 'cold waves' of the north-east States are stated to occur between December and March, and the insufferable 'hot waves' between June and September; but we think that November and May, respectively, ought to be included within these periods. Certainly in Europe the frosts of November and the heat-spells of May are already very emphatic.

We have only one serious charge to launch against this excellent book, and that is a certain backwardness of outlook, noticeable especially in the entire omission of any reference to the modern theory of the polar front. In the constant emphasis laid upon the violent changes of temperature which mark the passage of the great winter cyclones across the northern tier of States, as the wind shifts from a warm to a cold quarter, every meteorologist, certainly in England, will recognise that the United States is the very country where 'discontinuities' between 'equatorial' and 'polar air' attain their sharpest development, associated with intense cyclonic activity in winter, along the Great Lakes, in New England and Nova Scotia, as currents of warm, damp air from the Gulf of Mexico and the Gulf Stream interact with supplies of intensely cold, dry air from the interior of Canada, along the so-called polar front. It is not that the theory of the polar front is by any means the last word in the dynamics of cyclones; what makes the omission serious is that the theory furnishes a common-sense, geographic background of reference in studying the interchange of air between the equator and the poles that has made more powerful appeal to the imagination than any idea in meteorology for a long time. We hope, therefore, that in a second edition the facts of climate which illustrate this theory so forcibly in America will be translated into a terminology which has by now passed into common use by British and Continental meteorologists, and is certainly familiar in the United States itself.

We could wish in this, as in many other works, for a rather more instructive systematisation and categorisation of the geographical factors which control the distribution of climate. The geographical distribution of climate is determined by (*a*) latitude; (*b*) altitude; (*c*) a highly complex, interdependent set of factors connected with the distribution and character of land, water, snow, and ice comprised under the designation 'continentality and oceanity'; (*d*) mountainous configuration (as distinct from mere altitude) affecting rainfall and exposure to wind, sun, and frost. Now it is quite impossible to class prevailing winds which transfer continental conditions seawards (as in the eastern United States) and oceanic conditions landwards (as in the British Isles) other than as a sub-factor of (*c*). This emerged with unmistakable clearness at a fairly recent discussion of Spitaler's Continentality maps. (See *Geographical Journal*, July 1924.) Imagine a *uniform* globe, divested, that is to say, of all differential effects of land and sea, and of polar ice: it is clear that over such a surface the undisturbed planetary winds could produce no local climatic differentiation, that air currents changing latitude would, on the average, quickly readjust their temperatures, and that if any cyclonic eddies developed along a poorly marked polar front, they must be very different in character from those with which we are actually so familiar. In fact, on a uniform earth, factors (*c*) and (*d*) above, being obliterated, and (*b*) only existing with regard to the free atmosphere (since *ex hypothesi* there are no vertical inequalities), climate would be a function of (*a*) alone, as regards, at least, its geographical distribution.

In the United States, the planetary westerly winds normal to the latitude are powerfully affected by the monsoonal influences of the North American continent, being twisted over the eastern States into prevailing south or south-west winds in July, and north-west winds in January.

There is no better chapter in the book than that dealing with climate and health, together with the summer and winter health resorts of the United States; and we do not think that any member of the medical faculty could find fault with the philosophy displayed. It is clearly recognised that climate to a considerable extent acts indirectly on the human organism, and that the same phases of weather and climate may produce effects variously, for good or evil, according as hygienic, economic, and social factors are sound or faulty, and according to the level of health of the individual. In England, for example, we know that a spell of frost and snow sends up the crude death-rate, but we also know that the same weather is a fine tonic to those who can react to it and love the open air.

L. C. W. BONACINA.

The Psychology of Selecting Men.

The Psychology of Selecting Men. By Prof. Donald A. Laird. Pp. xii+274. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 15*s.* net.

ENGINEERS and chemists have long been an essential part of the staff of every large factory. No new machine is bought before it has been carefully examined and good proof evinced of its worth. Samples of raw materials are analysed by the chemists to observe their purity or strength. It is but recently, however, that the importance has been realised, in full, of the scientific selection of staff. The success of many a factory depends as much, or more, on the skill of the men who use the machines as on the machines themselves. It is no uncommon thing to find two operatives with equal experience, working side by side on similar machines, one of whom will produce half again as great an output as his companion.

How can selection be successfully made among applicants for a position? What method can be used to gain a true indication of their innate capacity for the work? Dr. Laird in the work before us has answered this question with as much detail as is at present available. His book is admirably planned. He starts by outlining the need for employment psychology, and then proceeds to show how its basis rests on the degree and extent of individual differences, and how it is generally safe to postulate that in an unselected group of individuals, these differences approximate to normal distribution.

The validity of the older methods of selection—the letter of application, the interview, the so-called "scientific character reader"—is discussed, and Dr. Laird gives definite proof that their selective value in many cases, especially with young workers, is little better than that obtained by chance. The unwary reader is himself trapped into making judgments from handwriting and photographs and thus shown his limitations. Many factors are concerned in the inadequacy of these methods. Often they measure irrelevant factors—you can tell but little of a prospective engineer's ability from his conversation, or of a carpenter from the letter he writes. But even in cases where the methods themselves have potential prognostic capacity, this is often lost through slipshod application, and lack of a standard by which to judge the results.

All this, however, is by way of introduction; though useful as a warning, it is merely negative criticism. The second half of the book is more constructive. There Dr. Laird is concerned with the use and evaluation of psychological tests of selection. Almost any sort of task can be used as a test if only it will give an accurate indication of the applicant's ability, or predict with great success his future performance. There is, as Dr. Laird says, no mystery about mental tests. "They are simply an application of the scientific method." The tasks, whether they are actual samples of the work, or simple trials of the fundamental capacities underlying ability at the work, must prove their worth before they are used. "They must show their consistency from day to day, their consistency from user to user, and their internal consistency of measuring what they aim to measure."

It must be remembered, however, that "tests are part of employment psychology, but by no means are they the sole contribution of psychology to employment." The interview and letter of application can be improved by making them more objective and supplying standards. It is especially important to analyse the personal data of successful and unsuccessful workers by group comparisons or other methods, to discover if there are any distinct differences in such matters between the two groups.

Dr. Laird's book is, as he says in his preface, "a product of necessity." The demand among employers for scientific assistance in the selection of their workers is becoming pronounced, perhaps even more in Great Britain than in America. The subject is still in its infancy and an enormous amount of research is necessary, but already psychological tests have proved themselves more than idle theory, and are in use in many offices, shops, and factories. They have been approved of alike by the employers who have benefited by the increased output, and by the employees who appreciate the justice of this method of selection. With such economic and social value their future is assured.

W. SPIELMAN.

Astronomical Physics.

Astronomical Physics. By F. J. M. Stratton. Pp. xi+213+32 plates. (London: Methuen and Co., Ltd., 1925.) 12*s.* 6*d.* net.

WITH the whole universe for its field of inquiry, astronomical physics is necessarily a very large subject, and an attempt to present its methods and results in a single volume of modest size can scarcely be expected to satisfy the requirements of all classes of readers. In some respects, however, the author of the book before us has achieved his task with distinct success. In the space of two hundred pages he has covered the whole range of astronomical physics from its beginnings to the most recent speculations in cosmogony, and we have failed to notice any subject of importance which has not received some mention.

The author's aim has been "to provide a useful book on the subject for the student, and one which every astrophysicist and not a few spectroscopists would want constantly within reach," and he has endeavoured to compensate for brevity of treatment by giving an abundance of references. As a guide to original sources of information the book will certainly be of great value to actual workers in astronomical physics, and to all serious students of the subject who have access to a suitable library. Physicists desiring to become more closely acquainted with the inter-relationships of physics and astronomy, which are becoming more and more numerous, will also find the book of great service, and to them it may possibly not appear to suffer from undue compression. It seems unlikely, however, that the book will appeal to the general reader, for whom it is to be feared that much of the text may be too sketchy for intelligibility. One wonders, for example, how such a reader would fare in trying to interpret the photographs showing Zeeman effects in sunspots (Plate 17) from the few lines of description which accompany them.

Historical references, instruments, and laboratory investigations form the subjects of the earlier chapters, and these are followed by others on the sun, the solar system, stellar radiation, motion in the line of sight, stellar classification, giant and dwarf stars, nebulæ, novæ, variable stars, stars with peculiar spectra, and, finally, by a chapter on speculations in cosmogony. Among the subjects most fully dealt with are the criteria for the various groups of the Harvard classification of stellar spectra, and the determination of the orbit of a spectroscopic binary. Misprints are very few, but attention may be directed to the unfinished deduction of the formula for the Doppler displacement on p. 83 and the necessity for substitution of u for u/c in the last equation.

The thirty-two plates which illustrate the volume have been well chosen and are satisfactorily reproduced. Diagrams are only four in number, and additional ones might have been introduced with advantage, as, for example, light-curves of typical variable stars. A number of useful tables, including standard wave-lengths, are given as appendices. It is difficult, however, to see the application to the subjects dealt with of the table for correcting wave-lengths to vacuum; a list of bright stars with particulars of their spectra and other characteristics would have been of greater interest.

As a summary of the main facts of astrophysics, and as a reminder on problems awaiting solution, the book is a welcome addition to the few works on the subject at present available.

Conduction in Nerves.

The Theory of Decrementless Conduction in Narcotised Region of Nerve. By Prof. Genichi Kato. New edition. Pp. v+166+6 plates. (Tokyo: Nankōdō, Hongo, 1924.) 3 dollars.

UNTIL Prof. Kato had contributed this most important monograph to the study of the nervous system, it had been held generally that a nerve impulse passing through a length of nerve which had been rendered un-normal in some way, as by the action of narcotic drugs, underwent a gradual diminution in its course ('decrement'), leading, if the narcotised region were sufficiently long, to its complete extinction. If the impulse did regain normal nerve without suffering extinction, it regained its normal magnitude to the full.

The author contends that this view is erroneous. He and his colleagues in Keio University have used in their experiments a sciatic-nerve-gastrocnemius-muscle preparation which is 10 centimetres long, obtained from the Japanese toad *Bufo vulgaris Japonicus.* Such a preparation may be put in a narcotising chamber without fear of diffusion from the outside—and consequent dilution of the narcotic—upsetting the narcosis of the region observed. By varying the length of the chambers and the narcotising solutions or vapours therein contained, or by observing the electrical responses from narcotised nerve, evidence is produced against there being a gradual diminution. The impulse is subnormal but it does not suffer 'decrement.' On reaching again un-narcotised nerve, the impulse becomes normal. When the degree of narcosis is pressed, excitability and conductivity disappear simultaneously.

The unusual length of nerve in the Japanese toad gives also latitude for observations on the spread of current along the nerve, which may be for a distance so great as 2 cm. This is claimed as another source of error which workers with nerve-muscle preparations of only European magnitude cannot avoid. In the array of careful experiments described in detail with their protocols are some in which the conditions simulated those of earlier workers, who of necessity have used smaller animals than the Japanese toad. Then the results agree, until, altering conditions and avoiding the error of diffusion in narcotisation and of escape of current, as is possible with the great length of nerve, it is shown that no interpretation involving decrement of the impulse can be permitted. On other aspects of the passage of the impulse in nerve there is no wide disagreement with previous observers.

There are many small printing errors. On p. 79, "entangled" for "disentangled" or "untangled" is probably the worst. The book deserves an index.

These small failings will not detract from the far-reaching possibilities of Genichi Kato's work and inspiration.

Our Bookshelf.

The Fight for Everest: 1924. By Lieut.-Col. E. F. Norton and other Members of the Expedition. Pp. xi+372+32 plates+2 maps. (London: Edward Arnold and Co., 1925.) 25*s*. net.

It would indeed be a strange personality which would not be stirred by this thrilling account, ending, alas, in tragedy, of the third expedition towards the summit of Mount Everest. The first in 1921 was in fact no more than a reconnaissance, the second in 1922 is described as "The assault," while we may well hope that the 1924 volume now published under the title of the "Fight for Everest" will be itself succeeded by the final volume, the "Attainment."

The introduction by Sir Francis Younghusband should persuade even the most cold-blooded reader of the value of such an effort. Most of the members of the expedition contribute a chapter or more: commencing with "The Start," by General Bruce, soon to be invalided back to the base and to be succeeded in command by Colonel Norton, there follow in succession (an enumeration of the chapter sub-titles tells the story), the march across Tibet, the Rongbuk Glacier, the North Col, Norton and Somervell's attempt, Mallory and Irvine's attempt, the return to Base Camp.

Mallory's letters, too, are fascinating reading, giving a glimpse of that enthusiasm which carried him and Irvine to their last final climb. The actual cause of their deaths will always remain a mystery. Did they reach the summit and fail to find their camp again or did they meet with an accident? We sympathise with the relatives and friends of those who died, a sympathy mingled with pride that Britain can still produce these men.

Second only to the last climb are those of Norton and Somervell and of Odell; a height of 28,000 feet seems well within the reach of such men, while it seems only a few years ago that a climb to 24,000 feet was considered an impossibility.

Part III. deals with the scientific results, the physiological effects, and the use of oxygen, as well as the natural history, geology and glaciology and photography, each of which are well treated.

Although newspaper articles and the well-known cinema, the "Epic of Everest," have familiarised us with most of the details of the expedition, this volume forms a valuable permanent record, well illustrated as it is with an exceptionally artistic map.

Landmarks in the Struggle between Science and Religion. By Prof. James Y. Simpson. Pp. xiv + 288. (London: Hodder and Stoughton, Ltd., 1925.) 7*s*. 6*d*. net.

One may surmise that in writing this book Prof. Simpson had in mind the religious layman rather than the scientific man, who will, we fear, find the discussions of early theology, especially in the first half of the book, somewhat wearisome. Prof. Simpson covers a very wide field, in theology, pre-history, science and philosophy. His book is erudite and well documented, and indicates a remarkably wide acquaintance with many extremely diverse branches of knowledge. There is, however, a certain disjointedness in the treatment of his almost superabundant historical material, which does not make for easy reading, nor is his central theme of the struggle between science and religion developed in any sustained and systematic way.

This said by way of criticism, we must remark on the competence and open-mindedness of the author's handling of a difficult and controversial subject. His attitude is that of a deeply religious man who is not afraid to accept all the well-substantiated results of science, and is able to harmonise them with his own beliefs. His position is that "Science describes, the philosophy of science explains, and religion interprets; and description, explanation, and interpretation are alike elements in the process of man's mental and spiritual adjustment or adaptation to the Universe. Each is necessary, the one to the other, and must enter into any intelligent understanding of the world as a whole. Science leaves us with descriptions which philosophy explains in terms of a phenomenal dynamic Universe; religion interprets the whole most satisfactorily, after an examination of all other interpretations, as the self-expression or unfolding of the activity of a creative God" (pp. 270-71).

We take it that science has no real quarrel with religion, as a certain attitude to the universe, but only with the accretions of dogmatic theology. That science had a hard fight to free itself from the trammels of theological and other dogmatic thought is made abundantly clear in Prof. Simpson's book, and vigilance is still necessary to preserve this hard-won freedom. But it is well to remember that the scientific man must beware of dogmatism also in his own sphere; he must continually test and criticise accepted theories lest they become dead and traditional; and he must guard against the danger of erecting a convenient method of science into a philosophy of life. E. S. R.

L'Adaptation. Par Prof. L. Cuénot. (Encyclopédie scientifique: Bibliothèque de biologie générale.) Pp. 420. (Paris: Gaston Doin, 1925.) 20 francs.

PROF. CUÉNOT has done biologists a service in writing this book. It contains treasures of knowledge, which have been treated with great skill and acumen.

Especially valuable, perhaps, are the sections distinguishing the different types of adaptation (necessary and sufficient adaptation, statistical adaptation, etc); those dealing with the important but limited rôle of what is usually called pre-adaptation; the assemblage of interesting facts on co-adaptation; the section on adaptations which are analysable into individual modifications and germinally-determined characters both acting in the same sense; and that on the reason for the rarity or absence of primitive and intermediate types.

Prof. Cuénot is perhaps less good on the bearing of mutations on the problem. It is difficult to see why he regards natural selection as only weeding out mutations which depart from the type: Why should not the neo-Darwinian scheme work with mutations as its raw material? Also, in his discussion of orthogenesis and co-adaptations, he often forgets, or seems to forget, the important fact that an organism's environment is largely composed of other organisms, and that therefore we should expect to find an improvement in one organism bringing out improvements in another, as improvements in naval guns brought out improvements in armour plate and vice versa. This principle will at least help to account for many (though probably not all) of the simultaneous, slow, 'orthogenetic' lines seen in palæontology. He could have accounted for some other orthogenetic phenomena by reference to the mechanisms of heterogonic growth (as summarised by Champy in his "Sexualité et Hormones").

Prof. Cuénot is sceptical as to the value of any of the existing explanations of adaptation, whether by Lamarckian means, by slow selection, by large mutation, or by predetermined orthogenesis. However, whether we share his scepticism or not, he has here provided considerable food for thought on one of the central problems of biology.

Penrose's Annual: the Process Year Book and Review of the Graphic Arts. Edited by William Gamble. Vol. 28, 1926. Pp. xvi + 146 + 70 + 57 plates. (London: Percy Lund, Humphries and Co., Ltd., 1926.) 8*s*. net.

THE editor, in his usual review of process work, says that he regretfully confesses that the year 1925, the end of a quarter century, shows "no new process, nor change of method, which is of outstanding importance; nothing, in fact, that could be regarded as a milestone of progress passed in the onward march of our art and craft." Much is being done, but it is in continuance of work started in previous years, especially since the War, and it may be expected to bear fruit in the immediate years to come. The editor then describes the remarkable progress that has been made during the quarter of a century just completed, which includes the introduction of the offset method and rotary photogravure. Colour gravure, based on three-colour principles, is making great headway, and an example is given of a flower study reproduced by this process, and also by a letterpress method from four blocks, so that the two results can be compared. Collotype is still printed on slow-running flat-bed machines which are turning out excellent work, and "it hardly seems likely that this practice will ever be altered." The progress of the various methods of replacing the ordinary type setting of text by photographic methods are passed in review, but it seems that none have yet convinced the printing trade of the advantages of these inventions over existing methods.

The text consists of 34 articles by experts, who give experiences or data of value. The curious chemical equation at page 129 shows that practical men should be content to leave theory to those that understand it. The fifth of the series of "The Work of the Private Presses" is by Mr. Chas. T. Jacobi on the Eragny Press, 1894–1914, and is illustrated with specimens. The numerous plates may be considered as showing the best that can be done to-day by perhaps every process that is in use.

A System of Physical Chemistry. By Prof. William C. McC. Lewis. (Text-Books of Physical Chemistry.) In 3 vols. Vol. 2: Thermodynamics. Fourth edition. Pp. viii + 489. (London: Longmans, Green and Co., 1925.) 15*s*. net.

THE third edition of Vol. 2 of Lewis's "Physical Chemistry" appeared in 1920, and included 445 pages of text. The fourth edition has been increased to 481 pages, mainly by the inclusion of half a chapter on "The Activity Theory of Evolutions" and half a chapter on "The Milner-Debye Theory of Strong Electrolytes." In accordance with the author's policy of quoting extensively from original sources, the latter section is taken from a paper by A. A. Noyes which appeared in the *Journal of the American Chemical Society* in 1924.

British Birds. Written and Illustrated by Archibald Thorburn. New edition. In 4 vols. Vol. 2. Pp. ix + 130 + 48 plates. (London: Longmans, Green and Co., 1925.) 16*s*. net.

THE first volume of the new edition of Mr. Thorburn's "British Birds" has already been noticed in these columns (September 12, p. 390); the second of the four has now appeared. The coloured plates are again very beautiful, but the amount of space given to rarities, in text and picture, continues to keep the treatment of more important birds within rather narrow limits. One is glad to note, however, the figuring of so many as three plumage-phases of the great spotted woodpecker, and that the immature plumage of the gannet is also shown.

Laboratory Manual of Elementary Colloid Chemistry. By Emil Hatschek. Second edition. Pp. 153. (London: J. and A. Churchill, 1925.) 7*s*. 6d. net.

THE second edition of Hatschek's "Laboratory Manual of Elementary Colloid Chemistry" contains new chapters on "Oxide and Hydroxide Sols" and on "Non-aqueous Emulsoid Sols and Gels." Methods for determining the coagulation velocity and for demonstrating the variation of viscosity with rate of shear have also been included.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Light Quanta and Photo-electric Emission.

I VENTURE to think that no theory has suffered so much from the application of an arbitrary selection principle to the consideration of experimental results as the quantum theory. The treatment of the whole subject, at least so far as it is concerned with X-ray phenomena—and in no branch of study is the acquaintance with the quantum rules and with their limitation so intimate—is based upon a very inadequate knowledge of facts. It could scarcely be otherwise when experimental acquaintance with the subject is so meagre For the present I should like to mention only one point.

The 'light-quantum' theory receives its strongest support in the phenomenon of electron emission when radiation is absorbed It is thought by some—apparently by many—that the "light-quantum" retains its individuality between the process of emission and that of absorption. May I then record an experimental fact bearing upon the subject?

The ionisation produced by a heterogeneous beam of X-rays in a gas or the electronic emission from a metal plate (measured by ionisation outside the plate) may be abruptly and enormously increased either by (*a*) superposing on that beam a very feeble radiation of slightly shorter wave-lengths, or (*b*) by taking away from the complex radiation a very small amount of the radiation of longer wave-lengths as by filtering; that is, either by adding higher frequency radiations to, or eliminating lower frequency radiations from the beam, the same effect is produced, namely, a sudden large increase in the ionisation. The magnitude of a sudden increase may be from 100 to 150 per cent of the original magnitude. This is the *J* ionisation produced by the *J* photo-electric emission accompanying the *J* absorption. Where then are the discrete and independent quanta?

These experimental results again show quite definitely that this *J* electron emission is an effect of the radiation as a whole. The quality of the full stream of radiation decides whether or not this shall take place. It appears (though this is much less certain) that the absorption is an absorption of all the constituents.

Such results were obtained by Miss White and myself six or seven years ago, but were withheld from publication until they could be confirmed by many experiments such as we have recently recorded (and others at present being obtained by Miss Mair), showing that these form part of a consistent whole. If then a small-angled prism of aluminium—a wedge—is placed in the path of a heterogeneous beam of X-rays, there is transmitted a spectrum of radiations varying in *average* wave-length, capable of showing both *J* absorption lines and *J* absorption edges by the ionisation method, as do homogeneous radiations. The phenomenon is now being studied photographically.

C. G. BARKLA.

University of Edinburgh,
March 6.

Eka-cæsium and a Suggestion about Radiation and the Elements.[1]

IN endeavouring to confirm the identity of the X-ray line 1·032 on Film No. 3 (see NATURE, January 30, 1926, p. 153), which would seem to correspond with the La_1 line of eka-cæsium (87) of calculated wave-length 1·0276, I have had this film intensified and then remeasured by Messrs. Adam Hilger, Ltd. (see *Chemical News*, February 12, 1926, p. 101).

The result is that the lines which according to the original measurement were 1·434, 1·232, and 1·032 now measure 1·434, 1·234, and 1·029, thus confirming the first values obtained, as it must be remembered we are not able to determine the lines very accurately, there being a possible error of 0·005, as previously stated.

The strong line of mercury, $L\beta_1$ of wave-length 1·0458, seems, however, to be ruled out, unless something has happened to the film originally. I understand that films on development tend to shrink rather than to stretch. This would not satisfy the suspicion that the line attributed to element 87 is the mercury one in question. There seems to be no other alternative than that the line is 87 La_1. More work in this field is obviously necessary.

Unfortunately, the first experiment cannot be repeated with the present apparatus, as there is now very little of the original material prepared by Dr. J. G. F. Druce.

Glass photographic plates are now being used in order to ensure greater accuracy, especially in measurement.

The question whether such elements as 85 and 87 can exist without being appreciably radioactive has been considered. There are several well-known instances of comparatively stable and even non-radioactive elements having the same atomic number as those which are very unstable, and uranium, the last-known member of the general series, is far more stable than most of those elements of somewhat lower atomic number. Therefore there is no absolute criterion as a guide in this respect.

Potassium and rubidium are feebly radioactive, but, curiously enough, no products from their radio-change seem to accumulate—at least, not so far as I know. If these common elements are contaminated with those of atomic numbers 85 and 87, and if these are radioactive, then the problem would only be partly solved. There is, however, no evidence of this kind. Both elements are mentioned on account of some statements to follow here

Those elements of high atomic number are unstable and they emit corpuscular radiation and electromagnetic radiation; that is, α-, β-, and γ-rays, with variations according to the radio-element considered.

Conversely, one might think of the elements at the other end of the general series as having absorbed such 'radiation' at one time in their history, and thereby growing into larger and larger atoms, as are now known. Blackett's well-known experiments on the disruption of the nitrogen atom by high-speed alpha particles, as previously accomplished by Rutherford, further reveal photographically, by using the C. T. R. Wilson ionisation cloud method, that when an H-particle (proton) is ejected from the nitrogen nucleus, the bombarding alpha particle, which caused the ejection, becomes absorbed in the nitrogen nucleus. Henderson's experiments indicate that capture and loss of electrons by alpha particles is also a process which comes under the general head of *mass absorption and mass radiation.*

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[1] The word radiation in this title is here used more particularly in the sense of *corpuscular* or mass radiation.

There is a further consideration: one might ask whether there could be a half-way state in which some elements spontaneously carry out both processes; that is to say, they absorb "radiation" and then emit it in the radioactive manner, as distinguished from the photoelectric effect proper. Some further statement seems necessary here, since at best the idea may only be a half-truth.

However that may be, this idea is suggested by the fact that potassium and rubidium spontaneously emit electrons (β-rays). Have we here the intermediate type of activity hinted at above? If these elements could absorb and then re-emit electrons, the process repeating, their radioactivity would be accounted for without the accumulation of disintegration products Furthermore, this dual process may reside in an impurity (elements) present in potassium and rubidium.

Considering again the experimental side, I have succeeded in exposing normal manganese phosphate (Kahlbaum's) for 10 hours without getting anything on the photographic film other than the copper lines (including a faint satellite in connexion therewith) and two almost invisible lines of wave-lengths 1·433 and 1·233. It would appear that these were the $L\alpha_1$ and $L\beta_1$ lines of element 75 of calculated wave-lengths 1·4298 and 1·2358. Berg and Tacke (*Naturwissenschaften*, 1925, 26, p. 571) calculate the values respectively as 1·4306 and 1·2355. The range of exposure was from the silver absorption edge to the copper $K\alpha_1$ and $K\alpha_2$ lines, which were, by the way, resolved. There was a good deal of phosphate on the anticathode I believe this experiment shows good technique Whether the above pair of exceedingly faint lines were those of Zn$K\alpha_1$ and $K\alpha_2$ combined, and Hg$L\alpha_1$, is partly immaterial to the present argument, for it suggests that it would be worth while examining potassium and rubidium in this way in order to detect if possible traces of, say, 87 in one of them.

This work is now in hand and the technique is steadily being improved. In these experiments the cathode should be in good condition; that is, not bored out by the anode rays.

The wave-lengths given above are in Angström units as before.

F. H. LORING.

The Magnetic Moment of the Orbit of the Valency Electron of the Solid Alkali Metals.

THE normal state of the atoms of the vapours of the alkali metals is an '*s*' state, the atoms consisting of a rare gas core round which revolves the valency electron in a n_1 orbit (4_1 for potassium, 5_1 for rubidium, 6_1 for cæsium). One would then expect that the vapours of these elements would be paramagnetic and that, when the diamagnetic properties of the rare gas cores were allowed for, a magneton number would be found corresponding to 1 Bohr magneton or 8·6 Weiss units. Data as to the magnetic properties of these vapours are apparently wanting, but the spectroscopic evidence leaves no doubt as to what is to be expected.

It is of some interest to see how far these predictions can be extended to the case of the solid state and what information the magnetic measurements can provide as to the nature of the atoms in the solid. If the lattice of the latter were built up of atoms in the same state as those of the vapour, one would expect that the metals would be paramagnetic, would follow the law $\chi(T+\Delta)=C$, and that, supposing Δ to have a value of the order usually found, the atomic susceptibilities of all the alkali metals would lie round about $+1300 \times 10^{-6}$.

If, on the other hand, there is a non-polar linking between the atoms of the solids, the valency electrons being shared by neighbouring atoms, one would expect that the total magnetic moment of the orbits of the valency electrons would be zero or nearly so on account of the complete or approximate compensation of the actual moments of the pair of shared orbits. The valency electrons would then contribute at most a small positive amount to the total moment of the atom and the substances would be diamagnetic. Probably, too, these shared orbits would not take a definite part in the thermal agitation of the atoms, and their positive contribution to the susceptibility would be independent of the temperature.

Further, it would be expected that the closest distance of approach between atoms of the solid alkali metals would then be smaller than the largest dimension of the n_1 orbit and larger than the radius of the rare gas core

The experimental data for the susceptibilities of the solid alkali metals have until recently been somewhat chaotic. Recent measurements by Miss Crow (*Proc Roy. Soc. Canada*, 19, 63, 1925) seem to be more satisfactory. The susceptibilities of solid potassium, rubidium, and cæsium, together with the contributions to the susceptibilities due to the rubidium and cæsium ions were measured with the following results: atomic susceptibilities K $-1{\cdot}9 \times 10^{-6}$, Rb -7×10^{-6}, Cs -8×10^{-6}, Rb$^+$ $-29{\cdot}8 \times 10^{-6}$,[1] Cs$^+$ $-37{\cdot}4 \times 10^{-6}$. We may add the value $-16{\cdot}4 \times 10^{-6}$ for K$^+$, being the mean of the figures given by Pascal (*C.R.* 158, 37, 1914) and Joos (*Zeits. f. Phys.*, 32, 835, 1925).

We thus see that the contributions to the susceptibility of the valency electrons are as follows: K $+14{\cdot}5 \times 10^{-6}$, Rb $+22{\cdot}8 \times 10^{-6}$, Cs $+29{\cdot}4 \times 10^{-6}$. A small correction for the diamagnetic properties of the actual orbit of the valency electron has still to be applied, but the values will remain of the same order of magnitude. It will be seen that these values are very much smaller than what would be expected for a normal n_1 orbit, but are of the order one would expect for the residual moment of nearly completely compensated shared orbits

The contributions of the valency electrons to the atomic susceptibilities are approximately in the ratio $4^2 : 5^2 : 6^2$ for K, Rb, Cs.

The susceptibilities of the solid alkali metals are also apparently independent of the temperature, and the closest distance of approach of the atoms in the lattice falls in between the values for the major axis of the n_1 orbit and the radius of the rare gas core, being 2·25 Å.U, 3·2 Å.U., and 1·55 Å.U. respectively for potassium.

Measurements of the magnetic properties of the alkali metals would thus indicate that the orbits of the valency electrons for the solid state are not the independent n_1 orbits shown by the spectroscopic data, but are shared by the neighbouring atoms to form a non-polar binding

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Chemical Effects produced by Resonance Radiation.

WE have read with interest the communication of Prof. H. S Taylor and his collaborators on the subject of chemical effects produced by resonance radiation, in which some exception is taken both to our experiments and to the conclusions given in our letter of December 19, p 899. It may be as well to indicate briefly the points on which we are in agreement and those on which a divergence of opinion apparently exists.

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[1] There appears to be an arithmetical error in the paper referred to, the mean for A/B being 449 and not 451, so that the susceptibility of Rb$^+$ is $-29{\cdot}8 \times 10^{-6}$ in place of $-29{\cdot}9 \times 10^{-6}$ as actually given.

It is generally agreed that the reactions under consideration involve the photosensitisation of mercury atoms, which on impact with hydrogen molecules render these in some way active for combination with gases. In our view, these reactions involve the simple addition of active hydrogen molecules to molecules of the reactants such as O_2, N_2, C_2H_4, CO. In a recent communication to the Cambridge Philosophical Society, this view was supported by the isolation of H_2O_2, the first step in the formation of water, and of N_2H_4, the second step in the formation of ammonia. The presence of hydrogen peroxide we note has now been observed by Prof Taylor. On the other hand, from the Princeton communications we gather that they incline to the view that the processes involve a series of chain reactions in which atoms and unstable groups such as H, C_2H_5, OH play a part, the chains being started by one excited mercury atom.

The second point on which some slight difference of opinion exists lies in the relation of a liquid mercury surface to the progress of these reactions. We agree that the mercury atoms forming part of the liquid are not active in photosensitisation: in fact, the selective action of the light λ2537 indicates that the absorbing atoms must be free from all constraints. The divergence in view is therefore concerned rather with the distribution of active mercury vapour in the illuminated system, when reaction is proceeding, than with the fundamental mechanism of the process. In the flow method large rates of reaction are obtainable with a continuous supply of fresh mercury vapour, but in a static system the mercury atoms in the gas phase apparently only preserve their photo-sensitising power for a very short time. Prof. Taylor apparently believes that the liquid mercury serves no other purpose than to supply by evaporation the wastage of mercury atoms in the homogeneous gas phase caused by chemical combination, *e.g.* mercuric oxide. We can confirm this removal in the case of the hydrogen-oxygen combination. Since similar results are obtained for hydrogen and ethylene, chemical removal may not be the only method by which mercury atoms lose their photo-sensitising powers.

This removal or loss of potential activity must proceed so rapidly that after but a short period of illumination the gas phase is almost devoid of active mercury atoms, and practically all the chemical action is confined, at high gas pressures at any rate, to a thin layer in close proximity to the liquid mercury

Finally, one small point remains. From the Princeton letter it would appear that these various reactions were discovered there and that, after publication of their results, work was commenced at Cambridge on the same lines. Without the least intention of detracting from the interest and value of the communications from Prof. Taylor, to whom we are indebted for the suggestion of employing a water-cooled arc, we must affirm that neither of these conclusions can be considered as quite correct. Franck and his co-workers may well be claimed as the discoverers of these reactions. Whilst it is true that our first note on our experimental work was contained in the letter referred to above, the apparatus had been constructed for us by the Thermal Syndicate in 1924 for the purpose of investigating these very reactions. Our early experiments were extremely unsatisfactory owing to the weakness of the resonance line obtained with air-cooled mercury arcs, and it is to Prof. Taylor that we are indebted for the suggestion of water-cooling. We may add for the information of the many other workers in this interesting field that the employment of an electromagnet in addition to water-cooling, as suggested by Prof. R. W. Wood, leads to a very considerable augmentation in intensity of the resonance light.

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The Subjective Analysis of Musical Tone.

EVERY one who has attempted to analyse a musical sound by the unaided ear and has acquired some experience at such work will recognise the peculiar nature of the difficulties met with. The first stage is, of course, to learn to concentrate attention on the particular partial sound sought to be recognised, and this is greatly assisted by previously sounding a note of the same pitch and firmly fixing it in the memory, as recommended by Helmholtz in his "Sensations of Tone." But even after one has acquired this habit of attention and has had years of practice and experience in acoustical work, the difficulty is only diminished and is not removed, as is shown by the fact that one may fail in some cases to distinguish a partial even if it be present, and that the use of a resonator is always a great advantage.

Helmholtz, in a chapter on the subject in his "Sensations of Tone," has discussed the difficulties experienced in the subjective analysis of sound at great length, and considers them to be the result of a natural tendency to fix attention on the synthetic rather than on the analytic characters of a compound sensation. This explanation is psychological rather than physical. That it does not go to the root of the matter is shown by a fact which Helmholtz himself mentions, namely, that it is easier to hear the unevenly numbered partials than the evenly numbered ones ; this suggests that we should seek for a physical and mechanical explanation rather than a psychological one. Further, it is possible to work under conditions which eliminate any explanation of the difficulty of subjective analysis as due to lack of attention When the observer has carefully prepared himself, as indicated above, *immediately* before an observation is made and his faculty of attention is at its highest level, he succeeds in observing the partial only in certain cases and not in others. From this, one may reasonably infer that the power of discrimination is limited chiefly by circumstances depending on the physical character of the sound and of the auditory mechanism of the ear, rather than by factors dependent on nervous perception.

Some observations recently made by me indicate that the difficulty felt in the subjective analysis of musical tone arises mainly, if not entirely, from the phenomenon of the masking of pure tones of higher pitch by those of lower pitch discovered by A M. Mayer (*Phil. Mag.*, **2**, 500, 1876), whose results have more recently been confirmed and extended by R. L. Wegel and C. E Lane (*Physical Review*, **23**, 266, 1924). Mayer discovered that sounds which are of considerable intensity when heard by themselves are liable to be weakened and even completely obliterated by graver sounds of sufficient force. The surprising character of this phenomenon must be experienced to be fully appreciated. That the auditory masking of pure tones of high pitch by those of lower pitch is the explanation of the difficulty felt in the subjective analysis of musical tone may be shown by simple experiments with a monochord. The observer selects a particular partial, say the 5th, for examination. By gently touching a node of this partial with one finger, and plucking the string repeatedly with another finger, the attention of the ear is fixed on the pitch of this partial. The damping finger is then removed, and the string is plucked sharply at a point not far from the end to elicit the full series of partials. The observer listens carefully for the 5th partial for a second or so, and then touches the string exactly at its node so as to damp out all the partials lower than the 5th. The 5th partial then sings out, and though theoretically its intensity should have been the same, actually a large *apparent* increase of intensity is usually perceived. The sound of the 5th partial, previously masked by the sound of the graver partials, asserts itself with vehemence when they are removed.

A further confirmation of these ideas is furnished by studies of the manner in which the audibility of the upper partials alters when the absolute intensity of the sound or its quality is varied. These details are reserved for consideration in a forthcoming paper.

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January 27.

Intensification of the Metallic Image in Gerlach and Stern's Magnetic Experiments.

IN the course of some attempts to measure the magnetic moment of the cadmium atom by a slight modification of Gerlach and Stern's original arrangement, a new method of intensifying the effect of a deposit of a very small number of metallic atoms on glass has been used, which although perhaps rather obvious has not, so far as I can ascertain, been employed for this purpose before. In Gerlach and Stern's first experiments on the silver atom a chemical method of rendering the deposit of atoms on the glass plate visible was used. In their later experiments on other metals it was found that in certain cases the deposit was visible without intensification, but in others it had to be developed by the same means. It is, however, plain that the use of comparatively huge quantities of liquid when dealing with a metallic deposit which may be at the most on the average only one molecule thick is dangerous, as solution of the deposit might easily occur. The method now to be described avoids this difficulty and is also probably easier to work. It depends on the fact that, while cadmium vapour at low pressures will not condense on a clean glass surface at ordinary temperatures, it does so readily at liquid air temperature. If, however, the smallest deposit of cadmium is already present on the glass, the vapour will condense on it at ordinary air temperature, quickly forming a visible deposit.

This phenomenon was originally discovered by Langmuir. He showed that by its use it was possible to obtain a visible deposit if only one cadmium atom per 3000 surface molecules of the glass was present. It is accordingly eminently suitable for our purpose. During the course of an experiment, the bottom of the glass flask on which the cadmium atoms impinge after passing through the magnetic field is immersed in liquid air. At the end of the experiment, to intensify the cadmium image, it is only necessary to remove the liquid air, allow the glass vessel to attain air temperature, and then evaporate a small quantity of cadmium inside the vessel by suitable means. The cadmium vapour will now only condense on the glass surface which has already a small trace of cadmium on it, and it has been found that a visible deposit quickly forms if any such trace is present. Blank experiments have also shown that if there is no cadmium originally present on the glass, no deposit will form. The pressure of the developing cadmium vapour must not be raised too high, as if this is done it may in certain circumstances condense on clean glass. In practice, however, it fortunately does not seem very easy to attain this state, especially if any metal objects are present in the vacuum, as the cadmium will readily condense on them, thus quickly lowering the pressure.

This method of intensifying small metallic deposits on glass can also be used in the cases of the other more volatile metals such as zinc and magnesium. It is also perhaps indirectly applicable to metals such as copper, which condense on glass at air temperature, as my experiments seem to show that cadmium vapour will condense on most metals at air temperature. Whether, however, a very few atoms of another metal will cause the cadmium vapour to condense I have not yet succeeded in proving, but on the whole the outlook seems hopeful. It is also possible that the presence of an electric charge on the surface of a quartz plate might cause condensation, but again this point has not been tried. However, without entering on these possible applications, it is evident that this method may be of great use in any experiments in which we have to deal with streams of either atoms or molecules the velocity of which is too low to affect a photographic plate, and the presence of which it is accordingly very hard to detect.

J. H. J. POOLE.

Physical Laboratory,
Trinity College, Dublin,
February 20.

Greenland or Polar Front?

No meteorologist could be less disposed than myself to underrate the importance of Greenland as a *factor* in determining the characteristic circulation over the North Atlantic Ocean, but I challenge the extravagant contention that cyclonic circulation, which is an integral part of the general circulation, depends *entirely* upon the "katabatic" operations of a relatively small and accidental feature in the configuration of the northern hemisphere like Greenland. To contend that the analogous Pacific centre of cyclonic activity, scarcely less intense than the Atlantic, is nourished by the same katabatic action of Greenland's ice-dome is surely out of the question.

Owing to pressure on space I cannot deal in any detail with the points raised in Prof. Hobb's letter to NATURE of February 13, but will briefly indicate the general line of reply. First of all, the discrepancy between the fact of relatively high pressure over the North Pole and the fact that the *Fram*, in the course of her drift in 1895 along the 85th parallel in the European sector of the Arctic, experienced a slight, 10 per cent, excess of southerly over northerly winds, can be reconciled by a closer study of Mohn's isobaric charts, which show a shallow elongation of the Icelandic pressure minimum north-eastwards towards Spitsbergen. With the trend of the isobars in this particular sector the slight excess of southerly winds recognised by Mohn himself is quite consistent But the major fact of the existence at all seasons of an "Arctic Wind Divide," shown by Mohn to lie across the polar basin between the Atlantic and Pacific minima, means that in the day-to-day changes there must be many occasions when air drains southwards over Europe whether reinforced from Greenland or not; and I am sure that any British weather forecaster will bear me out that there *are* many such occasions.

Secondly, the monthly distribution of the fog-frequency shows that only June, July, August, and September during the voyage of the *Fram* could in any sense be called foggy, the other eight months being, either absolutely or nearly, fogless ("Scientific Results of *Fram* Expedition," 1893–96, vol. 6, p. 572). But these fog statistics which Prof. Hobbs tries to turn in his favour have really little bearing on the argument at all, inasmuch as fog can exist at temperatures far below freezing; and, in any case, if fog-laden air moved outwards from the polar basin into warmer latitudes the moisture would soon be dissipated and the air become in perfect condition to form discontinuities with warm humid equatorial air along the polar front.

Thirdly, Prof. Hobbs is incorrect in underestimating the cold of the North Pole in winter, as Mohn's isothermal charts should convince him The Arctic Ocean in its outer portions is milder than the inner polar basin, and the fact referred to by Prof. Hobbs, that along the Arctic shores of Siberia and Canada southerly winds in winter are colder than northerly, is in accordance with the principle lately formulated by Dr C. H. Pollog of Munich, that where there is a sudden transition from land-ice to sea-ice, the air over the latter is warmer because heat is conducted upwards through the ice from the unfrozen water beneath (*Mitt. Geog. Gesell Munchen*, vol 27, No. 2, 1924).

L. C. W. Bonacina.

27 Tanza Road,
Hampstead, N.W.3,
February 19.

Parasitism of the Dodder.

The paragraph on Dr. Thomson's interesting work (1925) in Nature of February 6, p. 210, contains a reference to the results of "earlier observers" which I cannot pass without comment

Thomson found no phloem in the haustorium of Cuscuta, either in the shaft or in the brush of hyphæ; and no special connexion to the phloem of the host, corresponding with the xylem connexions. But Peirce (1893) described and figured both xylem and phloem in the shaft of the haustorium. This phloem I also found (1911), and Zender, who is not here, as the writer of the note states, in complete agreement with Thomson, also refers to phloem that is "only found in the primary portion" of the sucker (*Inst. de Bot. Genève*, 1924, p. 9). This phloem is small in amount; the sieve tubes are rather short, but quite typical and like those in the main stem of Cuscuta. Peirce and I cannot have differed in our descriptions of the position of the phloem in the shaft, as I did not attempt to describe the anatomical distribution of the tissues either of the main stem or of the shaft of the haustorium.

My work concerned mainly not the above typical phloem in the shaft but the strings of short sieve tubes in the distal part of the haustorium of Cuscuta. Here there are no elongated sieve tubes with well-bored-out sieve plates. This part of the haustorium is formed from the brush of hairs or 'hyphæ' which originate from the tip and sometimes from the sides of the haustorium proper. Thomson and others before him have described the formation of strings of short xylem elements from some of these invading hyphæ. I find similar strings of short phloem elements (perhaps better called sieve elements than sieve tubes) developed from other of the invading hyphæ, nearer the periphery of the brush. There is no possibility of regarding these elements as other than phloem, as there are well-defined sieve areas in their walls; one cannot mistake a typical sieve area properly stained by the safranin and London blue method, each deep red string surrounded by its blue callus rod. The method cannot be used with material which has been in alcohol, and histological work of this kind requires, of course, very high magnifications and critical illumination.

Just as, where a 'hypha' becomes attached to a xylem element of the host, the cell walls of the hypha become lignified, so in a hypha which is attached to a host sieve tube the division walls of the hypha develop sieve areas. These attachments do not appear to be so numerous as those in the xylem, but I found them quite as definite in the species I studied as did Zender. The wall of the hyphal tip disappears and the naked protoplasm is applied to the host sieve plate. The further very elaborate behaviour of the protoplasm inside the cavity of the host sieve tube, which is described by Zender, has not been seen by me.

I have explained that the statement that Peirce and I are "not in agreement as to the position of the phloem" is based on a misapprehension I hope I have made it clear that the evidence of independent observers renders the assertion that "the earlier observers . . . were in error in reporting its presence" somewhat hasty, especially as it is not possible to judge of Dr. Thomson's methods.

M. G. Thoday (Sykes).

University College, Bangor,
February 20.

Ozone and the Upper Atmosphere.

A benighted chemist, I listened with awe and interest to the discussion by the physicists on the electrical state of the upper atmosphere, on March 4, at the Royal Society. Apparently they were not quite at home above cloudland. The blessed word "ionisation" played a great part but did not seem to mean more than "conducting" Ozone was referred to with respect. Perhaps a chemist may be allowed to suggest a way in which it might serve as an "accumulator."

Those who attended the late Sir James Dewar's wonderful demonstrations at the Royal Institution may have witnessed the production of ozone, at the surface of liquid and even of solid oxygen, under the influence of ultra-violet radiation and will often have seen the glow of its decadence (to oxygen). Presumably, ozone is not the direct or immediate product of the action of such radiation upon mere oxygen but is formed *reversibly, in a complex electrolytic system*, in which oxygen is associated not only with a determinant (δ) but also with a catalyst (κ)—as the outcome of a series of interactions. I may refer to my article on "Catalysis and Oxidation," in Nature of August 22, 1925, p. 294, where I have discussed the process

The necessary conditions may well prevail in the upper atmosphere—they must, in fact, if it be formed at all. Let it be assumed then, that the condition be such, that the change of oxygen into ozone is not greatly encouraged—that it is difficult, on the whole, a large quantity being produced, during daylight, only because of the intensity of the solar effect. Then it equally follows, that the reverse action will take place only slowly and the accumulated energy be let down (electrically) only slowly, so covering the period of darkness, perhaps

It may be dangerous for the mere chemist to put foot down where the angels tread but lightly: still, these are matters to which we have paid some attention and our intervention may not be altogether foolish—the more if it lead some day to better appreciation of the philosophy of dirt, at present unnoticed by the physicist.

Henry E. Armstrong.

Weather Prediction from Observation of Cloudlets.

I WAS greatly interested in Mr. C D. Stewart's letter (NATURE, February 20, p. 270) which expresses my meaning exactly. But I do not know why he should think I regard "as a general method of prediction one which is applicable only in particular conditions, namely, those of showery uncertain weather, and, it may be, in particular localities; and also, to some extent, to the lack of precise definition of the type of cloud to be observed"—*i.e* "the smallest and thinnest fragment of cloud that can be clearly isolated." Captain Cave mentioned some exceptions, and I others. Before the rains in India, I have often seen big clouds form and then dissolve without dropping moisture. I wrote "only for the man who, perhaps knowing nothing about scientific meteorology, desires to ascertain for himself the kind of weather he is likely to experience during the next few hours." Such a one is not likely to examine the sky when it has settled to be wet or fair. Nevertheless, even during a downpour, if he is able to isolate a little dark cloudlet under the grey pall and see it dissolve, he may, even then, predict the early probability of finer weather with fair safety. Not long ago I arranged a game of golf under such conditions. I also wrote, "The nearer the cloudlet (the lower it is) the more closely do the conditions in which it floats approximate to those on the ground, and the more easily may it be observed; and, therefore, the more confident may be the prediction." Of course, therefore, I referred to 'doubtful conditions' and to the 'scud' which then occurs. My eyes, at any rate, cannot make sure of cloudlets very high in the sky, for, because of the distance, what seem to be cloudlets may be considerable clouds. Moreover, these high clouds are so remote, and the conditions in which they float so unlike those in which I stand, that observation of them can be of little utility for weather prediction. On the other hand, observation of the fact that the sky is clear for all the distance up to them gives me an indication of the continuance of fine weather. G. ARCHDALL REID.

March 9.

Ancient Coins from Pondoland.

IN Prof. Raymond Dart's article in NATURE, March 21, 1925, p. 425, reference is made to a find of ancient coins which Prof. Dart states was made in Pondoland by Mr Cook about fifty years ago (p. 427).

At considerable trouble I have traced these coins, and find that there are several very peculiar circumstances regarding them, which I consider throw a completely new light on the whole question.

The coins fall into three distinct groups:

(1) Ptolemaic.
(2) Late Roman.
(3) Byzantine.

Groups (1) and (2) have been accurately described by Prof. Dart. Group (3) consists of two much-defaced coins—a small copper of Constantine II. and a large copper of John I. Now, since this last is the latest coin in the find, and it cannot be given an earlier date than A.D. 969, and since it is so worn that the obverse is completely obliterated, I suggest that the earliest possible date for the burial of the horde would be about a century later, say A.D. 1070, by which date the Arabs were established at Sofala and were probably trading as far south as Inhambane.

Roman coins still, I believe, pass in the Peninsula, and it is quite possible that all the pieces in the find were imported by Arabs.

One most striking feature about the whole thing is the amount of wear shown by the different groups. The Ptolemaic coins are in fair condition, many of the late Roman group are almost in mint state, though others are more or less worn. The Byzantine coins, on the other hand, are so worn that I had considerable difficulty in identifying them. But when it is born in mind that the horde covers from first to last a period of more than twelve and a half centuries, one ceases to be surprised at anything.

J. F SCHOFIELD.

P.O., Durban, February 16.

Uncertainty.

MY exuberant friend Prof Armstrong (NATURE, Feb. 6, p. 195) seems uncertain about many things for which there is good evidence, and to glory in his uncertainty; but there is no merit in uncertainty in itself: it is just as much a sign of crankiness to reject good evidence as it is to accept bad. His attitude prevents his own enjoyment of the great discoveries of the present generation, because they do not dance to the *drone* of his water bagpipe—a serviceable instrument but in danger of becoming a fetish I can only suppose that in his educational policy he has so long refrained from dogmatic instruction, and so persistently advocated other methods as more truly educative, that now he can scarcely recognise a true doctrine when he encounters it

Yet the object of science is truth, not hesitating ignorance; and though caution is admirable it may degenerate into obscurantism Prof. Armstrong would probably have been on the side of the orthodox in the days of Galileo, and might now justify himself by relativity; but progress and truth were on the side of Galileo nevertheless, however crude his formula. A pioneer is usually ahead of orthodoxy.

In his letter, Prof Armstrong virtually asks me to withdraw from the Royal Society because I have gradually reached complete conviction on a subject of age-long debate and uncertainty, and have said so while as yet the majority of Fellows still doubt. I can promise that when such a request is made officially I will resign promptly without giving trouble; but I will not refrain from stating what I firmly conceive to be the truth, as demonstrated by clear and repeated evidence, whenever such statement seems called for If I had any uncertainty about it I would say so, but it is madness to be false to truth—no matter what the penalty may be OLIVER LODGE.

Italy, February 10.

The Constitution of Glauconite.

IN a recent paper (*Rec. Geol Surv India*, 1925, vol. 58, pp. 330-337) Dr. L. L Fermor proposes for glauconite a formula analogous with that already given by Clarke, which I had regarded as inadmissible (*Min. Mag.* 1922, vol. 19, pp 330-333). Dr. Fermor's conclusion is based on the fact that the mean of the glauconite analyses agrees with this formula. But, as he himself shows, the composition varies widely. Indeed, it would be equally logical to derive a rational formula from the mean of the published analyses of plagioclase. Dr. Fermor concludes: "It must be pointed out that . . . the formulæ given are based on averages, and that many of the individual analyses depart considerably from these formulæ." It was exactly for this reason that I felt compelled to reject the formulæ in question in favour of one which agrees almost perfectly with nine out of the twelve analyses available for this rather obscure mineral A F. HALLIMOND

49 Cromwell Avenue, N 6, March 1.

The Electrical State of the Upper Atmosphere.[1]

By Prof. S. CHAPMAN, F.R.S.

DIRECT simultaneous measures of temperature and pressure up to 25 kilometres, by sounding balloons, give complete information as to the variation of pressure, density, and temperature over this range. The temperature falls in the first 10 kilometres from 285° absolute to 220°, and then remains constant up to 25 or 30 kilometres. The temperature above this height was a subject merely for speculation until Lindemann and Dobson published their theory and discussion of meteors. They concluded that the temperature remains at 220° up to 50 or 60 kilometres, after which it rises (perhaps rather rapidly) to about 300°, which is its value up to about 140 kilometres; thus at this height the air is warmer than near the ground. This rise of temperature is inferred from the estimated densities of the air between 60 and 150 kilometres, the density at 100 km. being more than ten times as great as it would be if the temperature had remained at 220°. Higher up the difference between the estimated density and that calculated on the latter assumption is still greater. The mean free molecular path, calculated on the assumption that the air is mainly nitrogen over this range, increases from about 1 cm. at 90 km. to about 10 cm. at 130 km.

Above this level, even if the temperature were fully known, the pressure and density could not be inferred without a knowledge of the composition, as to which, at present, there is much uncertainty. In the lowest 10 km. the air is thoroughly mixed by winds, but at some height H in the stratosphere diffusive separation may begin, the heavier constituents settling out so that the proportion of the lighter constituents steadily increases upwards. Up to about 100 km. the pressure and density do not depend much on H, but the composition is largely affected by it: $H = 20$ km. and $H = 50$ km. would give very different results. If we take $H = 20$ km. as a likely value, nitrogen is still the main constituent at 100 km., its molecules being about fifty times as numerous as those of oxygen and helium. Above 150 km. there will be very little oxygen, and such lighter gases as are present (possibly helium and hydrogen) should be the main constituents.

The question of the composition at 90 km. or 100 km. is of interest in connexion with the auroral spectrum. The conditions there, in any case, are by no means those of a large excess of helium, as supposed by McLennan and Shrum in their discussion of the auroral spectrum. The auroral spectrum shows that nitrogen and oxygen (accepting McLennan and Shrum's identification of the green auroral line) are present at auroral heights. At the lower auroral levels this is quite in accordance with expectation, but auroræ are also said to appear at heights of 500 km. The evidence for this, given by Störmer and Vegard, seems quite satisfactory. The presence of nitrogen and oxygen at such levels seems explicable only on the assumption that the atmosphere is partly supported at great heights by electrical forces, such as were discussed by Atkinson in his criticism of Vegard's theory of the aurora. If such electrical forces operate, either permanently or merely temporarily when auroræ occur, they may have the effect of allowing the lighter gases, hydrogen and helium, to escape altogether: a suggestion which would, if substantiated, explain the rather remarkable absence of hydrogen and helium lines from the auroral spectrum.

Another matter of interest concerning the upper atmosphere is the highly conducting layer, the existence of which is indicated by the diurnal magnetic variation, according to the theory of Balfour Stewart and Schuster. The conductivity of the layer must be of the order 3×10^{-6}, which is so great as to be difficult to explain. But recently Appleton and Barnett have assigned 10^5 as a lower limit to the number of electrons per c.c. at the level, about 80 km. high, at which wireless waves are reflected at night. From this it appears that the specific conductivity must be 10^{-14} c.g.s. units at this height; a layer having this specific conductivity would require to be 3000 km. thick to account for the total conductivity 3×10^{-6}. This excessive thickness can be reduced to a more reasonable figure, however, if the ionisation by day is several times as great as by night (as the diurnal magnetic variations themselves indicate), and if allowance is made for the increase in the mean free path above 100 km. The downward extension of the conducting layer, by day, into regions where the mean free path is less than at 100 km., may not add very much to the total conductivity. There seems no longer, however, any insuperable difficulty in supposing the thickness of the conducting layer to be of the order of 200 or 300 km., without assuming an excessive specific conductivity.

By Sir HENRY JACKSON, G.C.B., F.R.S.

Radio communications have never been noted for their consistency. At first this was attributed to atmospheric disturbances and to the low energy emitted, with reception by unreliable apparatus, but when the power radiated was greatly increased and modern appliances of great sensitivity and constancy were brought into daily use, it was still found that the intensity of the received signals from any station at long distances was variable at times, though it was seldom if ever that signals were entirely lost at the stations designed to receive them. When directional wireless was brought into use, it was found that, in addition to variable strength of signals, great variations were experienced at night in the bearings of the observed stations.

The cause of these variations in intensity and direction have been very systematically investigated during the last five years by the International Union of Scientific Radiotelegraphy and others, and in Great Britain - especially by the Radio Research Board; many hundreds of thousands of observations have been made by skilled observers with suitable and reliable apparatus, and the results have been carefully analysed to try to find a law which could explain the reason of the variations.

The analysis showed plainly that both types of variations were subject to seasonal, diurnal, and 'untraced' effects, and that the altitude of the sun had evidently a great effect on them, but nothing more definite than this was obtained. However, in considering the effects of electromagnetic waves of radio frequency on a wireless receiver, it was deduced that the causes of variation in signal strength and direction could all be accounted for if two or more waves from the same source and of the same frequency reached the receiver simultaneously but at different phases of their oscillations, and for some directional variations, if one of them was polarised in a different plane from the others.

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[1] Contributions to a discussion at the Royal Society on March 4.

When shorter waves than those employed (until about four years ago) came into general use for broadcasting and also for communications, another variation came prominently to notice; namely, the rapid variations in signal strength called 'fading,' though probably this is only an exaggeration of the first-mentioned effect; and also the fact that although signals may be received at short and also at long distances, there are intermediate zones in which no signals on the wave-length in use can be received at all, or only very occasionally. The Kennelly-Heaviside layer theory had not been lost sight of in the investigations already referred to, and the most recent theories on this were studied and experiments carried out to try if deflexions and conduction by some such agency as this layer could be measured. This has been successfully accomplished by several observers using different methods, and the collective results they have obtained, and independently published, I think, go far towards establishing the validity of the idea. Before a decision can be given, however, it is necessary to know what this deflecting layer must be able to do to meet the calls that are now being made upon it to account for all the varying results that are now observed in radio communications which cannot be attributed to locality, to the apparatus in use, or to the personnel operating it. I will briefly give some typical examples of these, with short waves; those with long waves and directional apparatus have been well known for a long time.

The quantitative effect of the earth's attenuation of moderate and long wave-lengths passing over its surface is not accurately known, but it varies as some power of their length. For high power and long wave stations, such as Rugby, Nauen, and others of this type, it seems possible that this effect is small, and the wave may cover the whole of the earth's surface, and to a lesser extent with shorter waves with less radiated energy; the layer in this case would act principally as a deflector of the waves downwards. But in the case of the very short waves, say less than 50 metres in length, experiments show they are rapidly attenuated by the earth, and not received directly at any great distance from the transmitter.

With Admiralty permission, I will quote a very recent example showing this, namely, with a wave of 12 metres in trials now being carried out under carefully organised conditions and supervision. A ship starting on a long voyage transmitted this wave according to programme every 4 hours for 12 minutes. The signals were regularly received with diminishing clarity up to 100 miles of one of the shore stations, then lost until the ship was 1100 miles off, when they were again received for some days intermittently, and again at about 3500 to 4000 miles, lost again, and then received again with perfect clarity at 6000 miles.

Now this is a case in which the phase difference I previously mentioned cannot well have been the cause, for the ship on its passage either directly or obliquely away from the receiving station, would pass through a wave-length and any of its various phases in about 2 seconds, and in the 12-minute period of transmission would have every chance of changing any phase difference between two waves arriving at different angles.

The small loss (if any) of signal strength at 6000 miles is very noticeable, and from personal observations on four other wave-lengths from this ship, emitted every 4 hours according to programme, I have been able to compare their strength and behaviour with others of the same wave-length emitted by two other Admiralty shore stations similarly equipped, at distances of 90 and 1100 miles respectively The three stations send consecutively, the ship coming in between the other two, the shore stations. The signals from the nearest station are, on the average, decidedly weaker than those from that at 1100 miles. Those from the ship vary, sometimes being very weak, at other times very strong, but at the extreme distance reached, 6500 miles, they were noticeably weaker than when under 5000 miles, at which distance I have received them without Æ or E. Fading of these signals is also noticed, during both day and night, from all three stations, but is more irregular and frequent from the ship at great distances than from the other two (30 per cent. from ship, 22 per cent. from shore stations: 300 observations); but generally, when one of the stations fades, the others do as well. Reception seems better from all three stations when they are transmitting in darkness than in daylight, especially the one at 90 miles on the longest of the wave-lengths. Occasionally double fading is noticeable, that is, a short period of small amplitude, superposed on one of considerable period with large amplitude, *e.g.* 10 seconds and 2 minutes, with amplitudes of 2 to 4, and 0 to 6 in the usual scale of telephone intensities.

At other times, from the ship at long distances, the dots if made fast disappear or are very faint, as if it took an appreciable time to build up sufficient intensity to start the signal on its way. Occasionally long dashes from the ship at long distances are distorted into an audible wave of varying pitch and intensity. Communication on two of these short waves seems to be reliable during some part of the day to the extreme distance the ship reached.

With a longer wave (nearing 100 metres), signals were maintained at night up to 1000 miles, then lost and only received twice in the remainder of the voyage though transmitted 6 times daily.

These results indicate that the layer must exercise but little attenuation on short waves, which show little loss of energy in their passage along it, but that it appears to deflect down some wave-lengths at various places, and others possibly at all points over the earth, and that two or more waves must sometimes reach the receiver in varying phases to account for the extraordinary fading effects that are so often noticed with them.

Is a layer that will fulfil all these functions a physical possibility, is the question which requires an answer; *if not*, what is the cause of these variations?

By Dr. W. H. Eccles, F.R.S.

Preceding speakers having marshalled the available evidence for the Heaviside layer, it may be most useful for me, while agreeing broadly with the conclusions drawn from that evidence, to refer to some other points of view and other agencies. For example, in connexion with wireless phenomena at short distances from the transmitting station, the diminution of the density of the air with increase of height, which causes the lower atmosphere to act as a prism with its base on the ground, taken together with diffraction, must be remembered. Consider a source from which electric waves of length 20 metres, 600 metres, and 20,000 metres are being simultaneously emitted, and consider especially the rays emitted horizontally. Up to distances of 100 kilometres, all these waves can be detected by an ordinary aerial—beyond that distance the 20-metre waves vanish but the others remain perceptible. This, I suggest, indicates diffraction of the longer waves, as is supported by the fact that an aerial on a high mast or hill can detect short waves passing overhead like the beam of a searchlight. I want to suggest also that variations of signal strength at these short distances may be due to variations in or movements of the lower atmosphere. (The well-known vertical oscillations of pilot balloons at a height of 10 kilometres suggest movements of the air.)

Beyond 100 kilometres, in daylight, the 20-metre signals are completely lost, the others are continuously perceptible. It has been found (*e.g.* by Hollingworth) that after falling off with distance, the long wave signals increase up to a distance of 400 kilometres. Here it seems that the ionised atmosphere is aiding diffraction and the prismatic action. At 700 kilometres the lost 20-metre signals reappear, though the tangent plane through the source passes 100 kilometres above. This suggests that the horizontal rays from the source have followed a trajectory perhaps only 30 kilometres in height at its apex and now graze the ground again. Rays starting with an upward angle from the source would, on this view, descend to earth at greater distances and perhaps at grazing incidence. These possibilities have caused me to remain unconvinced by Prof. Appleton's use of the 'skip' of short waves to deduce the maximum electron density at a sharply defined Heaviside surface nearly 100 kilometres high. This possible explanation by the aid of non-intersecting and gradually bending trajectories of varying height demands considerable thickness in the Heaviside layer. It is perhaps in disaccord with Sir Joseph Larmor's recent review of an old theory; for he appears to deny the possibility of bending in the lower atmosphere and also supports the 'whispering gallery' view, which assumes the formation of a thin caustic layer of radiation in the sky.

The preceding remarks refer to daytime propagation. At night the 20-metre waves make a larger skip, say 4000 miles, and are picked up at all distances beyond; the 600-metre waves are picked up at all distances to 5000 miles, and the 20,000-metre waves go everywhere. Measurements are available on the medium wavelengths and show that in the great fluctuations of strength beyond 2000 miles, the maximum may exceed the strength calculated for a perfectly conducting flat earth with a non-absorbing atmosphere. This seems one of the best proofs of the existence of the Heaviside layer, for otherwise we must believe that the earth is flat.

The Glaciers of Savoy.

An important and unusually interesting report, of more than two hundred pages, on the glaciers of Savoy, especially those of the Mont Blanc "massif," the Tarantaise Alps, and those of Haut Maurienne, has been recently issued by the Ministère de l'Agriculture, Département (Direction Générale) des Eaux et Forêts. It is entitled "Études glaciologiques," and represents most valuable results, from the beginning of the century down to the year 1920, obtained by a special "Commission glaciaire de Savoie," composed of high officers of the Département des Eaux et Forêts, aided by specially appointed geologists, geodesy experts, M. Tairraz, the well-known Alpine photographer of Chamonix, and the late M. Joseph Vallot of the Mont Blanc observatory. In spite of the unavoidable reduction of the staff during the War, several members indeed being among the fatal casualties, the work was continued throughout the terrible four years 1914–1918.

The results achieved consist in annual, and in some important cases monthly, measurements of the lengths of the glaciers, determinations of their relative movements at the sides, snouts, upper surfaces, beds, and various parts of their width, estimations of their depths, total volumes, amounts of water they discharge at their lower ends, their gain by snowfalls, and their loss by solar fusion. In addition, a careful record has been compiled of all catastrophic occurrences, such as exceptional avalanches, bursts of lakes and water pockets, earth-quakes and -tremors which have resulted in avalanches or alterations of beds and configurations; and to render this portion of the report still more interesting, historical data have been added concerning all known happenings of this character since the year 1800.

During the last ten years (1910–1920) of the period dealt with, the glaciers on the Savoy side of the chain of Mont Blanc have in general been advancing. For example, the Glacier du Tour reached its minimum length and showed a tendency to grow in 1909, and although there was a slight set-back in 1910 due to special solar activity, in 1911 a distinct move forwards was made, and has continued without interruption up to the end of the report period, 1920. The progressive movement was only communicated to the Argentière glacier four years later, in 1913, as regards maximum length, but even from 1911 there was a growth of several metres a year on the right flank of the snout, until the total length became at last affected in 1913, and the elongation became more and more marked until in 1920 the glacier end moved forwards 40 metres.

The Mer de Glace was difficult to investigate, as its end had been hidden, by its retrogression, in an inaccessible ravine. But from such observations as could be got of the snout, and especially from those on the glacier proper above the Montanvert, it is clear that there has been a forward movement occurring, ever since 1916 with certainty, and probably from 1914. From further observations of the higher portions known as the Glacier du Géant, and of its tributaries, the Glaciers de Leschaux and Talèfre, it is shown that there has been a very considerable increase in the bulk of the glacier, an augmentation of thickness having been observed ever since 1913.

The Glacier des Bossons, the central glacier of Mont Blanc itself, offers the most interesting results, for owing to the snout being so readily accessible by the exceptional advance of the glacier on to the very meadows of the valley of Chamonix, it has been found possible since March 1917 to obtain monthly records of progress. They show that the glacier does not advance *en bloc*, but with a waddling motion, sometimes one side, sometimes the other, and sometimes the middle of the front, moving most during the month, like a heavy man walking in such a manner as to advance each shoulder alternately. Moreover, in summer the left of the front moved, on the whole, the more rapidly, and in spring and winter the right; the former is due to greater melting of the ice on the side showing least motion, and the latter to the form of the glacier bed, the line of maximum movement of a sinuous glacier being, as is well known, on the convex side of the central line of the glacier, that is, nearer to the concave border. Since the year 1910 the annual march of this glacier has varied from 33 metres during the first year (July 1910–July 1911) to 51 metres in 1917, from which it slowed down to 23 metres in 1920. The advance was greatest in spring, then next in summer, then in winter, and slowest in autumn. The mean values for the four years 1917–1920 were 11 metres in spring, 5·2 metres in summer, 5·1 metres in winter, and 1·7 metres in autumn. In spring there is extra pressure from above, owing to accretions from the névé of the higher snowfields, undiminished by melting, as the spring sun has first to melt the fresh winter snow. But in summer the movement is diminished by real fusion and thereby loss of solid ice, combined with reduced pressure from above, the weight of the winter snow having been removed by melting.

The Glacier de Bionnassay has been advancing since the year 1916 with certainty, and probably since 1914. The last measurements had been in 1913, and between then and 1916 the front of the glacier had advanced 30 metres. It continued at this rate more or less steadily down to the report period 1920.

Thus it is clear that the glaciers of the French Savoy side of the chain of Mont Blanc have all advanced, the amount being accentuated in the cases of the steeper glaciers, Le Tour, Argentière, and Les Bossons. In the more slowly moving cases, the Mer de Glace and the Trélatête glacier, the increase has been chiefly one of bulk and of thickness.

The glaciers of the Tarantaise, and other Savoy Alps, which are much influenced by the Lombardian winds of the valley of the Po, have either advanced to a less amount than those of Mont Blanc, or have retrogressed. The latter, for example, has been the case with the Glacier de la Vache (Source de l'Isère).

Special reference should be made to the particularly interesting determinations of the thickness of certain glaciers. The late M. Joseph Vallot obtained results on the Mer de Glace, at widely different positions in its course, which varied from one hundred to two hundred metres of solid ice; and he came to the conclusion that the latter figure represents the maximum depth. This estimate is almost exactly confirmed by these later measurements and estimations by the Department des Eaux et Forêts, the opinion being that, if not quite accurate, it errs on the low side.

The observations conclude with some remarkable estimates of the volume of additional ice represented by the advance of these glaciers. The Glacier du Tour has increased per annum between 1911 and 1920 by the amount of eight and a half million cubic metres. The glacier of Argentière has increased in volume by one to three million cubic metres per annum of solid ice; and the Mer de Glace has shown a similar amount of swelling, until in 1920 the exceptional heat caused a slight net loss. The Bossons glacier has enlarged by amounts varying from one-sixth to one-half million cubic metres a year. The glaciers of Bionnassay and Trélatête have gained in volume of solid ice between 1912 and 1920 more than five million and seventeen million cubic metres, corresponding to an increase of thickness of the glaciers of seventeen and six metres respectively.

The French Department des Eaux et Forêts is to be most sincerely congratulated on this magnificent piece of accurate work. It is to be hoped that the observations have been carried on beyond the year 1920 in an equally satisfactory manner, and that they will be continued. It would appear that this is being done, for the writer has several times come on the officers of the department at work during his recent summer visits to the Savoy mountains, both Mont Blanc and the Tarantaise Alps, including one paid this last summer, and has had personal experience of the admirable way in which the measurements are being carried out.

A. E. H. TUTTON.

Obituary.

SIR PHILIP WATTS, K.C.B., F.R.S.

SIR PHILIP WATTS, who died on March 15, was born in May 1846, being thus nearly eighty years of age when he died. He was educated at the Dockyard School at Portsmouth and the Royal School of Naval Architecture, South Kensington, completing his education in 1870. Until 1885 he spent most of his time at the Admiralty on the Naval Constructor's staff, which afterwards became the Royal Corps of Naval Constructors.

During this time Sir Philip was engaged in the design work of the office which then produced such original designs as the *Inflexible* with 24 in. of armour and four 16-in. 80-ton guns; the *Iris and Mercury*, the first all-steel ship and the fastest then produced; the *Polyphemus*, an armoured ram which was almost submerged; and many other original designs. He assisted Mr. Wm. Froude in the classic observations on the behaviour of the battleship *Devastation*, one of the first of the mastless turret ships in H.M. Navy. He took a leading part in the investigations of the *Inflexible* Committee, which was created as the result of doubts expressed as to the fighting and seaworthy qualities of that ship. He designed the rolling chambers of the *Inflexible*, and went to sea in her to observe the effects of the chambers on rolling.

Sir Philip was thus associated with most of the scientific development of naval architecture at the Admiralty between 1870 and 1885, at which date he began his independent career in charge of the design and construction of warships at Armstrong's works on the Tyne, in which position he remained until 1902, when he accepted the position of Director of Naval Construction at the Admiralty. His active career as warship designer extended for well over half a century, and during this time he was associated with a continuous increase in efficiency and battle power of the many ships for the design of which he was the responsible creator. His reputation stands unrivalled for the quantity and quality of his work. Of the warships which he designed and built when at Armstrongs, the cruisers were the fastest and best armed of their day, and the battleships were the most powerful. Nearly all the warship fighting done by the Japanese victorious fleet in 1894 and 1905 was done in Watts's ships.

When Sir Philip went to the Admiralty, two of the King Edward class of eight battleships had been commenced. He produced designs having much greater gun power, and not inferior in other respects, with the view of building a squadron of eight ships much more powerful than the King Edwards, but My Lords decided to complete the inferior ships. This was discouraging to the man who wanted to give our ships as much gun power as possible. On the appointment of Admiral Fisher as First Sea Lord, however, Sir Philip's chance came, and he had hard work to give Fisher all the guns he wanted. The all-big-gun ship was wanted. Its adoption was approved by the Committee on Warship Design appointed to consider the question, and the Director of Naval Construction produced the complete designs for the Dreadnought type approved by that Committee. Thus, by the energy of Fisher and the skill of Watts, was begun the series of Dreadnoughts and super-Dreadnoughts of which the Grand Fleet was largely composed—which, to adapt the phrase of Mahan, stood between the Germans and the conquest of the world. Watts could not have attained and maintained such a position without a very full knowledge of all that pertains to warships, not only the structure of the ship but also the principles underlying armour, gun and machinery production, and a full appreciation of the strategy and tactics of sea warfare and of the life and ambitions of the great sailors of his time.

Watts was one of the earliest graduates of that school of naval architecture which began in the 'sixties, developed in the 'seventies into the Royal Naval College at Greenwich, and has continued ever since to turn out men of high attainments to fill not only that able Corps of Naval Constructors (over which Sir Philip presided) but also the Royal Naval Engineers, who have so ably assisted in the enormous developments of marine engines which have taken place since the school was founded. Sir Philip, like his predecessors and successors, saw to it that this source of supply of naval constructors and engineers was fully maintained. He assisted in the creation of the professional chairs and the schools of naval architecture in Glasgow, Durham, and Liverpool, from which so many naval architects and marine engineers have graduated and have found scope for their abilities in the ship and engine works of Great Britain.

Sir Philip's great scientific attainments and his practical skill in applying his knowledge were recognised by the Royal Society, of which he was a fellow and vice-president, and by the universities which conferred on him LL.D. and D.Sc. degrees. It was, however, in the Institution of Naval Architects that his work was best known. He contributed many papers of high value and always took an active part on the Council of the Institution. He frequently presided at the council and general meetings, being for many years the senior vice-president. When at Armstrong's he was an enthusiastic territorial gunner and had the rank of Colonel. He was not a great talker in public or private, but all who had the privilege of his friendship will remember him as a generous and genial man with sound common-sense and wide scientific interests, which, combined with a gifted imagination and great courage, enabled him to carry through his important work successfully.

PROF. ERNST EHLERS.

PROF. ERNST EHLERS was born on November 11, 1835, in Lüneburg in the kingdom of Hanover, where his early education, carefully supervised by his father, who was a merchant, was received, and where the ancient buildings and historical surroundings doubtless had an influence on his sensitive mind. His training consisted of a good knowledge of classics, of history, mathematics, French, and chemistry, whilst his natural bent found a congenial field in faunistic works. He then (1857) proceeded southward to the University of Göttingen, where he energetically studied medicine and natural science, two subjects so intimately related, as all history shows, that the efforts of the late Scottish Universities Commission to separate them are vain. Amongst the professors there, none interested him more than W. Keferstein, R. Wagner, and Bödeker. There were comparatively few zoologists of the period who, like Ehlers, entered on their later studies with broad views and a thorough acquaintance with both vertebrate and invertebrate anatomy. It is true in his early days he had not the advantage of a life on the sea-coast and of familiarising himself with marine life from Protozoa to mammals; but he balanced this by his able researches on structure and by his skilful pencil, so that amongst the distinguished zoologists of the period he stands prominently forward.

Ehlers' abilities and natural bent were soon observed by Keferstein, who took the young naturalist with him to Naples and Messina, introducing him to the rich marine fauna there, the joint authors producing a memoir on the Siphonophores. In 1861 he received the degree of M.D. at Göttingen, his thesis being the "Anatomy of *Priapulus caudatus*," the material for which he had obtained from the well-known Japetus Steenstrup of Copenhagen. The same year he was appointed prosector to the Anatomical Institute of Göttingen, and two years later a private tutor in zoology and comparative anatomy.

His association with the leading zoologists of Germany and Austria led Ehlers to select the fine field for work in the group of the polychæts, so that in an expedition (May–August) to Fiume in the Adriatic, he worked his nets and searched the beach specially for those forms, to the study of which he applied modern methods. A better seaman than his distinguished countryman, Albert Kölliker (who was helpless in the surging English Channel), he was enabled to make full use of his opportunities in these waters. Ehlers began systematic work in the polychæts at a time when—by the labours of Grube, De Quatrefages, Johnston, W. Baird, Agassiz, and others, they were attracting attention everywhere—no less from their beautiful coloration than from their wonderful structure and life-histories; and he resolutely, from first to last, adhered to their elucidation both as regards European and more distant seas.

Ehlers' two early volumes "Die Borstenwürmer," each with about a dozen quarto plates, were by their careful systematic treatment sufficient to lay the foundation of a solid reputation, and they attracted much attention in Great Britain, so that when the results of the *Lightning* and *Porcupine* Expeditions were dealt with, Ehlers was assigned the polychæts dredged below 500 fathoms, and they formed a valuable contribution in the *Zeit. f. w. Zool.* for 1871. It would not be possible to deal minutely with his great labours —even in the polychæts—which added many new genera and species to the group, and brought to light new features in their structure and life-history; for his observations ranged from the fossil forms in the Solenhofen slate to the most recent deep-sea expeditions of his own country and of the Americans, and extended from the Atlantic to the shores of New Zealand, as well as ranging from pole to pole. Some of his memoirs formed quarto volumes of considerable size, and most were finely illustrated, sometimes in colour, by his skilled artist, O. Peters. He was *facile princeps* in the Department in his day, yet he bore himself with perfect modesty and was ever ready to help others. Nor were his labours confined to the polychæts. The gephyreans, tunicates, and Bryozoa on one hand, *Lepidosiren*, the Porbeagle shark, the *chorda dorsalis*, and the anatomy of Manis on the other hand, each became the subject of one or more memoirs—thus demonstrating the versatility of his vigorous mind and his indomitable powers of work.

Ehlers' connexion with the *Zeitschrift für wissenschaftliche Zoologie*, the leading journal of zoology in his country, dates from 1875, when the veterans Von Siebold and Kolliker added him to the staff, and as the seniors passed away he became sole editor —until lately. His entrance into this work was signalised by an increase in the size of the journal, and indeed it occasionally doubled its bulk both as regards memoirs and plates. Yet he did not desert the Gottingen publications, in which many of his contributions appeared afterwards. The name of Ehlers is honoured wherever the science of zoology is known, and he truly wore the sword out instead of letting it rust out, for he held office until he had almost reached his ninety-first year, when release from his labours reached him. His unselfish devotion to zoology moved his friends, at home and abroad, in 1905 to prepare a *Festschrift* in his honour, and the memoirs were published in the *Zeitschrift f. w. Zool.*, and are a sufficient testimony to his fame. Moreover, a second *Festschrift* was in process of arrangement in 1914, but the outbreak of the War put an end to the project. Ehlers thus forms a conspicuous example to all the younger zoologists for his unswerving devotion to his early subjects, his wide and accurate knowledge, his skill with his pencil, and for his arduous and unceasing academic labours. Of him Gottingen may well be proud.

W. C. M'INTOSH.

DR. C. V. PIPER.

BY the death, on February 11, of Dr. Charles Vancouver Piper, the United States Department of Agriculture loses a worker of wide reputation and long service. At the time of his death he was in charge of the Office of Forage Crop Investigations, and through his efforts many plants and grasses of much value to American agriculture have been introduced and established in the United States. He was best known to the general public through his work in developing the creeping bent grass for use on golf greens. In 1919 he discovered a particularly useful variety, propagated it by vegetative means, and distributed it throughout the northern section of the United States, where it is now found growing on thousands of golf greens. Dr. Piper was keenly interested in the game, and utilised his knowledge to the full to improve conditions for players everywhere.

Dr. Piper's contributions to the forage and grass industry of practical agriculture were numerous, perhaps the best known being the introduction and establishment of the Sudan grass (from Africa), which is now a very valuable hay and pasture grass in the States. More than one hundred books and papers on agriculture and allied subjects stand to his credit, and he was consulting agricultural editor for the McGraw-Hill Book Company. In his search for new forage plants he travelled widely, spending much time in Japan, China, India, Java, Egypt, the Philippines and Alaska.

Dr. Piper was born at Victoria, B.C., in 1867, took his M.S. degree at Washington in 1892, and remained there as professor of botany until 1903, when he received his appointment to the Agricultural Department at Washington, D.C. He was associated with many societies, serving in 1908–9 as president of the Botanical Society of Washington, and in 1913–14 of the American Society of Agronomy.

WE regret to announce the following deaths:

Dr. William Tufts Brigham, director-emeritus of the Bernice Pauahi Bishop Museum, Honolulu, known for his work on Hawaiian customs, on January 29, aged eighty-four years.

Sir Bradford Leslie, known for his work on bridge design and construction, who studied his profession under Brunel, on March 21, aged ninety-four years.

Dr. William E. Safford, economic botanist for the United States Department of Agriculture, who devoted himself to the study of the plants and plant products of the American aborigines and of the early history of cultivated plants generally, on January 10, aged sixty-six years.

Prof. Sutherland Simpson, since 1908 professor of physiology in Cornell University, Ithaca, and formerly lecturer in experimental physiology in the University of Edinburgh, the author of numerous papers on the nervous system, body temperature, and secretory glands, aged sixty-three years.

News and Views.

THE controversy which has arisen through the Admiralty Order of November 1925, which adversely affected the status of engineer officers in the Royal Navy, has been carried a step further by the publication of the Memorandum drawn up by the Joint Committee of the Engineering Institutions. We referred to the deputation which waited upon the First Lord, the Right Hon. W. C. Bridgeman, M.P., in our article "The Status of the Naval Engineer" in our issue of February 6, p. 185. Mr. Bridgeman's written reply is evidence of the conservatism which seems to pervade the Admiralty, and the reply of the Committee states that "they view his statements with grave concern as a symptom of the attitude of mind prevailing at the Admiralty." The Committee adds that it is proposed to take steps both in the Press and in Parliament to make its views known to the public. It certainly seems an anachronism to-day, when the engineering branch is of such vital importance, that the Engineer-in-Chief has not a seat on the Board, even when matters affecting his department are discussed.

THERE is an aspect of the question of the status of the engineering personnel of the Royal Navy to which attention should be directed. The Admiralty has published particulars regarding the forthcoming examination for special entry cadets, eight of whom will be required for the executive 'category' and twenty-five for the engineer 'category' of officers. On previous occasions when the engineering personnel question was in the limelight, there was a serious falling off in the number of candidates. We hope that this will not be the case now. The Navy never stood in greater need of the pick of our schools than to-day, and though parents and guardians may view with distrust the policy of the present Board of Admiralty, we believe that, in spite of the temporary set back it is suffering, the engineering branch of the Royal Navy has an ever-increasing national duty to fulfil.

AT the invitation of the Prime Minister of the Commonwealth of Australia, Sir Frank Heath, head of the Department of Scientific and Industrial Research in Great Britain, has for some time been inquiring into those problems presented by Australian primary and secondary industries which call for thorough scientific investigation. His object has been two-fold: to discover directions in which work in Australia may be linked with that now being carried on in Britain, and to advise the Government as to the most effective way of reorganising the Commonwealth Institute of Science and Industry. In his several public speeches on the subject of industrial research, Sir Frank has emphasised three points. The first is the present lack in Australia of thoroughly trained investigators, which is accentuated by the slight opportunity afforded to university science teachers for extensive research work; the second is the urgent need for thorough understanding and co-operation between Commonwealth and State governments; the third is the necessity for concentrating at first upon problems of the primary industries. He has also emphasised the fact that the magnitude of the Australian continent greatly increases the price which Australia must be prepared to pay for adequate scientific investigation of her numerous problems. The distance factor, indeed, makes the general Australian problem of organisation very different from, and in some ways much more difficult than, that which is being met in England by the Department which Sir Frank Heath superintends.

THE Friday evening discourse at the Royal Institution on March 19 was entitled "Chips from a Sculptor's Studio," and was given by Mr. John Tweed, who designed the equestrian statue of Sir George White in Portland Place. As a practical sculptor Mr. Tweed told how a statue is made. The size and material are chosen to suit the surroundings—bronze being the most suitable if the statue is to be exposed to the weather. Expression is first conveyed to the clay sketch. The material is on a skeleton form. The process the Egyptians first used was the plaster cast and then the finished work in the material chosen The thinness of the bronzes used by the earlier artists cannot be attained at the present time, and there is need for science to discover a more suitable bronze for statuary. In sculpture proper, carving in marble is done with a specially designed instrument by a carver, and then the sculptor completes the work. The material naturally used by the Greeks was marble. The artist gets his inspiration by studying Nature, that he may show the aspect of Nature in his work. Photographs of examples of Egyptian and Grecian sculpture in various materials were shown.

ACCORDING to a dispatch from the *Times* correspondent at Delhi, the Assembly on March 18 rejected the proposal of the Government of India to vote a sum of 375,000*l*. to the Institution of Archæological Research Fund. The proposal was strongly opposed by several Hindu members, who put forward the claims of university and medical education, and by English unofficial members, who argued that the establishment of an equivalent British Museum fund would remove archæological investigation from the annual criticism of the legislature. As no provision had been made in the Budget for archæological research in the expectation that the proposal would be accepted, it was agreed that a supplementary demand for 15,375*l*. should be submitted on the following day. The decision of the Assembly will cause profound disappointment to those who appreciate the importance of the work which is now being carried out by the Archæological Department and are acquainted with present conditions in India. It had been anticipated with some confidence that this vote would place archæological studies in India on a sound basis and would enable a scheme of research covering a period of years to be framed, affording an opportunity of training workers in the principles and methods of archæological investigation—a matter of supreme moment now that the discovery of a centre of prehistoric culture in the Indus Valley is likely to give investigations in this area an importance in the history of civilisation at present incalculable. Sir John Marshall in a recent speech, in referring to the discoveries at Mohenjo Daro and Harappa, spoke of the possibility of inviting co-operation from outside; but whatever form such co-operation might take, there should be some assurance that India itself will be prepared in the main to accept responsibility for the continuance of this important work by competent and fully trained archæologists.

THE forthcoming polar flight of Captain R. Amundsen was the subject of a recent lecture in Rome by Col. U. Nobile, who will command the dirigible airship of the expedition. The lecture is now published in an illustrated pamphlet containing maps of the route From a study of weather conditions in the Arctic regions, Col. Nobile believes that spring offers the best chance of steady weather and long range of visibility. He thinks that the flight should be made not later than May. The route will be from King's Bay, Spitsbergen, where mooring-posts for the airship are now being prepared, to Point Barrow in Alaska. This route crosses the heart of the unknown area in the Beaufort Sea, and should lead directly across Crocker Land, if that land exists. A problem of some importance is the selection of a route to Spitsbergen from Rome. The alternatives are Rome, London, Pulham, Trondhjem, Spitsbergen; or Rome, Fredericks-haven, Leningrad, Murmansk, Spitsbergen. The second route is 500 miles longer than the first, but offers greater probability of quiet weather conditions, and would appear at present to be the route selected. Col Nobile expresses great confidence in the prospects for a successful flight.

WITH the object of giving the American public a bird's-eye view of the services rendered by the National Bureau of Standards, a special circular has been prepared in which its activities are described in non-technical language It contains 113 pages, 86 illustrations and a plan of Washington showing how the Bureau may be reached. The visitor is supposed to be taken through the various departments in turn, and is told the main purpose of each and how it is attained. In many cases some striking result which has followed from the work done in the department is mentioned, as for example the scientifically designed gas burner which gives an efficiency four times that of the usual burner and will effect a saving of 50,000*l.* per day to the United States; and the standardisation being gradually introduced into industry which will reduce the number of unnecessary sizes and varieties of products. The circular forms an interesting and important document and should remove any misgivings as to the great value of the Bureau as a national investment.

MR. C. LEONARD WOOLLEY'S monthly progress report of excavations in Mesopotamia on the site of the temple of the Moon Goddess at Ur, which appeared in the *Times* of March 16, records several discoveries of exceptional interest. Among these is a small chamber containing three stelæ inscribed with the name of Bur-Sin, apparently a shrine for the cult of the deified founder of the temple—a find unique in Mesopotamian discoveries. There is also a diorite statue of the goddess Bau, patroness of the poultry-yard, in the form of a squat seated figure in an elaborately flounced dress, which is the first female statue of early date to be found in Mesopotamia. An alabaster lunar disc dedicated by a daughter of Sargon of Akkad (2750 B.C) shows in relief a sacrifice to the goddess by a priestess, who may be the princess herself, while a limestone plaque dating from well before 3000 B.C, an excellent example of the early art of the country, carved in relief in two registers, shows sacrificial scenes in which in one case the king, and in the other a priest and priestess, pour libations to the god.

VOL. 69 of the Memoirs and Proceedings of the Manchester Literary and Philosophical Society contains the inaugural Ludwig Mond Lecture delivered in the University of Manchester on October 20, 1924, by Prof. H. B. Dixon. Prof. Dixon traces in an interesting manner the rise of the alkali manufacture and the share which Ludwig Mond had in its development. In partnership with John Brunner, Mond started the Solvay ammonia soda process at Winnington in 1873, and in the face of really imposing difficulties they made the process, which had failed in the hands of previous technical men, a success. Mond's contributions to pure and applied science are recorded, and his generosity in helping research is especially commented upon. Ludwig Mond was an example of a rare combination of keen interest in pure science with great ability in its application to the problems of industry.

SOME account of Russian scientific exploration in Arctic Russia and Novaya Zemlya is given in several recent issues of the *Weekly News Bulletin* of the U.S.S.R Society of Cultural Relations with Foreign Countries. For the past four years an expedition under Prof. Samoilovitch has been at work in Novaya Zemlya, and succeeded last summer in rounding the northern end and exploring the little-known north-east coast, discovering several new gulfs and making minor changes in the charts. A site has been chosen for a radio station, for meteorological purposes, at the northern end of the north island. Another expedition under Prof. Suvorov has been exploring the little-known Cheshskaya Gulf of the Kanin Peninsula and examining the fisheries of the coast. Investigations in biology and anthropology have also been conducted in Kolguev and the Kola peninsula, and experiments have been made in several districts of the north in the use of a serum against anthrax in reindeer. All these and other researches are to be continued next summer.

In the National Museum of Wales at Cardiff there are two important collections of British Lepidoptera, the Vivian and the Griffith, which together comprise more than 50,000 specimens. The authorities of the Museum have recently issued a "Guide" (price 6*d.*) to these collections, which directs attention to many interesting and scarce specimens of which no previous record has been published The occurrence and distribution of various Lepidoptera in Wales are also indicated in this pamphlet, while a number of the rarer species are illustrated on two coloured plates. The booklet will prove of interest to collectors and others with respect to unique or very rare specimens contained in the collections, since it gives the localities and other data associated with them. So much is heard respecting the disappearance of rare or local Lepidoptera that it is refreshing to learn from this pamphlet that, at any rate, the white-letter Hairstreak, *Thecla w-album*, appears to be extending its range in so far as Wales is concerned.

The "Report of the Health of the Army for 1923," recently issued, contains details of some interest. Judging by the invaliding rate, the health of the Army was better in 1923 than in the previous two years, but not so good as in the period 1906–13. It is surprising to learn that tonsillitis takes third place, with 5566 cases, as a cause of admission to hospital, malaria with 13,158 cases and venereal diseases with 10,807 cases being first and second respectively. No definite reason could be assigned for this high incidence of tonsillitis. At the head of the list of diseases which cause the greatest amount of invaliding out of the Army comes inflammatory conditions of the middle ear, with 451 cases—nearly half a regiment! The Royal Army Medical College, in addition to courses of instruction and research work, now prepares all the bacterial vaccines and allied substances employed in the Army, which were formerly purchased, at a saving estimated at 12,650*l.* for the year.

Dr. R. E. M. Wheeler, since 1924 Director of the National Museum of Wales, has been appointed Keeper, Secretary, and Accounting Officer of the London Museum, in succession to Mr. F. A H. Oates, who has retired.

Probably no division of biology has so many journals devoted to its various aspects as entomology. A new American periodical, *The Pan-Pacific Entomologist*, a quarterly journal of general entomology, was inaugurated last year. The first volume, consisting of four numbers, has been completed and vol. 2 is now appearing. The journal is published by the Pacific Coast Entomological Society in collaboration with the California Academy of Sciences. Although primarily intended for furthering an interest in the entomology of the coastal region of the Pacific side of America, papers of broader significance are not precluded The annual subscription is 2 dollars for the U.S. and Canada, and 2·25 dollars for elsewhere. Sample copies are obtainable from Mr. F. E. Blaisdell, 1520 Lake Street, San Francisco, California.

Reference has frequently been made in the columns of Nature to the difficulty experienced in central European countries, since the War, in gaining access to outside scientific proceedings and publications. In many of the smaller Continental universities this condition still prevails, and cannot be ameliorated owing to the lack of funds for the purpose. Much valuable assistance could be rendered in this matter, however, if workers in the various branches of science were to make a point of sending reprints of their publications to the leading Continental exponents of the subject concerned. In physics, the need of such an arrangement is particularly acute at the present time, when two "Handbucher" of physics are in preparation. Prof. K. W. F. Kohlrausch has been entrusted with the volume on "Radioactivity" in one of these "Handbücher," and he has written to us suggesting that workers in radioactivity forward to him their publications in this subject, so as to enable him to bring his work completely up-to-date by first-hand reference to original papers. He would be very grateful if the authors of such papers would assist him in this manner, by sending reprints to · I. physikalisches Institut, Technische Hochschule, Graz (Austria).

At the Southampton meeting of the British Association in August last year, a number of papers were read by officials of the Ordnance Survey. These papers are now collected and printed in full in Professional Papers, New Series, No. 10 (H.M S.O., price 9*d.*), and include an admirable general account of the work of the Ordnance Survey by Col. E. M. Jack; a paper on recent productions by Capt J. G. Withycombe, in which announcement is made of a new three-sheet map of Great Britain on a scale of 10 inches to a mile; a paper on archæology and the Ordnance Survey by Mr. O. G S. Crawford; and an account of the present state of the international 1/M map by Maj. M. N. Macleod. The publication gives a useful summary of the present state of the survey and maps of Great Britain.

Messrs. Gurney and Jackson announce the early publication of "A Text Book of Organic Chemistry," by Prof. Julius Schmidt, translated by Dr. H. Gordon Rule; and "A Text Book of Inorganic Chemistry," by Prof. Fritz Ephraim, translated by P. C. L. Thorne.

Catalogue No. 398 of Messrs. Bernard Quaritch, Ltd., 11 Grafton Street, W.1, will appeal to zoologists and geologists, especially if they are interested in rare and choice editions, for it contains particulars of nearly 1800 works, many of which are out-of-print and scarce.

Messrs. H. K. Lewis and Co, Ltd., have recently issued two interesting lists of second-hand books dealing respectively with "Early Scientific Works and Biographies," and "Early Medical Works—Medical History and Biography." Either list, or both, can be obtained free upon application.

Applications are invited for the following appointments, on or before the dates mentioned:—An assistant to carry out research work on miners' electric lamps—The Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (April 9). A junior chemist at the Building Research Station, Garston, near Watford, for investigations on the heating and ventilation of buildings—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (April 10). A professor of zoology in the University of Cape Town—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (April 14). A professor of physics in the University of Tasmania, Hobart—The Agent-General for Tasmania, Australia House, Strand, W.C 2 (April 15). A junior scientific officer for work connected with aeronautical instruments at the Royal Aircraft Establishment—The Superintendent, R A.E., South Farnborough, Hants (April 17) (quoting Ref. A. 107) A principal of the Sir John Cass Technical Institute—The Correspondent, Sir John Cass's Foundation, 31 Jewry Street, Aldgate, E.C 3 (April 24). A junior lecturer in mathematics, a lecturer in geography, and a lecturer in geology and palæontology at Bedford College for Women—The Secretary, Bedford College for Women, Regent's Park, N.W 1 (May 8). A professor of natural history in University College, Dundee—The Secretary and Registrar, The University, St. Andrews (May 8). A professor of physics in the University of Dacca, Bengal—The Registrar, University of Dacca, East Bengal, India (June 30). A test assistant for aircraft and instrument test work at the Aeroplane and Armament Experimental Establishment, R.A.F., Martlesham Heath—The Secretary of the Air Ministry, Adastral House, Kingsway, W.C 2 (quoting S. 2/R 461). An assistant lecturer and demonstrator in botany at the South-Eastern Agricultural College, Wye, Kent—The Secretary A pathological laboratory assistant for the Veterinary Department of the Government of Nigeria—The Crown Agents for the Colonies, 4 Millbank, S.W.1 (quoting M/14292).

Our Astronomical Column.

PENUMBRAL LUNAR ECLIPSES.—The January issue of *L'Astronomie* contains an article by M. Gaetan Blum on this subject. Consideration of these eclipses is necessary to make the theory complete; when they are included there must be one lunar eclipse at every passage of the sun through either node, and there may be two. The almanacs as a rule do not give predictions of penumbral eclipse, but they have done so occasionally by some caprice. Eclipses in which the moon penetrates deeply into the penumbra are quite readily observable, it being obvious that a portion of the moon is dimmed by a smoky veil. There will be an eclipse of this kind on December 19 next, full moon being at $6^h\ 8^m$ A.M., so that it will be visible in Great Britain. The least distance of the moon's limb from the umbra will be less than a minute of arc. The article notes that the phenomenon is rendered more noticeable if the moon's light is weakened by reflection at an unsilvered glass surface.

A very instructive diagram shows all the eclipses of a Saros cycle (1908 to 1926), different symbols being used for each species of eclipse. It brings out clearly both the approximate 4-year cycle of recurrence and the much more exact one in 18 years 11 days.

The same publication contains a photograph of the solar eclipse of January 24, 1925, taken by Prof. Slocum at Middletown, and a diagram showing the exact position of the southern boundary of totality across New York as deduced from the observations made there.

THE JOHANNESBURG 24-INCH REFRACTOR.—This instrument is now in full working order, and is giving satisfaction The outer portion of the lens is less good than the rest, so a slightly diminished aperture is employed

Dr. Van den Bos, of the University of Leyden, is engaged on an exhaustive search for southern double stars with the instrument He has already found more than 180 new pairs, while according to a message which was published in the *Times* some weeks ago, the star β-Tucanæ has been found to consist of three separate pairs, making a splendid sextuple system. This rapid increase of the known southern binary systems calls for a new general catalogue of these objects, which is now in course of preparation at the Union Observatory. It is being printed by a typewriter and will be issued in separate sheets, so that new pages can easily be inserted

It is noted that the planet Pallas appeared on a recent occasion exactly like a close binary star, and was for a time mistaken for one.

THE TEMPERATURE OF SUNSPOTS.—A preliminary paper on this subject by Prof. V. Bjerknes appears in *Comptes rendus*, 182, 48, 1926. The author has contributed largely to the dynamics of meteorology, and his important investigation on the "Dynamics of the Circular Vortex" will be found in *Geofysiske Publikationer*, vol. 2, No. 4, Christiania, 1921. In the present paper the general principles previously established by him are applied to the problem of sunspots, in which the relative coolness is considered by him as an analogous phenomenon to the relatively low temperature in terrestrial cyclones. He postulates a fluid medium possessing a free surface and the properties of a gas with density increasing downwards more rapidly than would result from compression. For a horizontal vortex in such a medium, Prof. Bjerknes develops an expression for the fall in temperature ($\Delta T = T - T_0$) in the central part of the vortex—nat. log $T/T_0 = 2D/H$, where D is the depth of the depression of the free surface, and H is the depth to which vortical motion extends. Applying this formula to a sunspot vortex, given $T = 6000°$, the following depressions of temperatures are given:

$D/H =$	0·001	0·01	0·1	0·2	0·3	0·4	0·5
$\Delta T =$	12°	120°	1100°	2000°	2700°	3300°	3800°

It is found as a corollary that the velocities in corresponding vortices should range from a fraction of a kilometre to 20 km./sec The theory is stated not to be invalidated by the possible absence of a free surface in the sun, so long as there is a rapid change in the densities of the solar gases from photosphere outwards.

It may be added that the temperature of a sunspot at photospheric level is generally considered to be about half that of the photosphere itself. Prof. H. N. Russell, in a "Note on Cooling by Expansion in Sunspots" (*Astrophysical Journal*, 54, 293, 1921), gives as the temperature of the photosphere 6000° C.; of the spot at the same level, 3500° to 4000° C.; at base of the spot vortex, probably 20,000° C. (rough estimate).

Research Items.

STONE IMPLEMENTS FROM NIGERIA.—The Geological Survey of Nigeria has issued as Occasional Paper No. 4 a communication by Mr. H. J. Braunholtz, describing a number of stone implements of palæolithic and neolithic types found in the alluvium of the Bauchi Plateau. Their discovery is a by-product of the tin-mining industry, which necessitates removing and sifting large quantities of alluvial deposit in river valleys. The depth at which they are found varies from a few feet to 30 feet. Unfortunately this affords no criterion of age, and further, the exact location of the finds has not always been recorded. In some cases, however, the depth and situation taken together seem to argue a considerable antiquity such as, *e.g.*, a site "under 20 feet of alluvial and 85 yards from the recent river edge." The implements are, with one possible exception, of local rock and of local manufacture. The palæolithic implements are made of a quartz porphyry, the neolithic of basalt (dolerite). Many of the former are much rolled. Allowing for differences due to the employment of a different material, the palæolithic implements resemble western European types of the Chelles to Le Moustier epochs, but not of the later palæolithic times. While the neolithic types are widely distributed in Nigeria, the Bauchi Plateau is the only site in the provinces up to the present on which palæolithic implements have been found The absence of late palæolithic forms suggests either an isolation of Nigeria from ultra-Saharan Africa at this period, or lack of stone suitable for finer flaking, or, possibly, a more recent origin than their typological affinities in North Africa and Europe.

PAINTED POTTERY FROM MESOPOTAMIA.—Mr. W. F. Albright, of the American School of Oriental Research, Jerusalem, describes in *Man* for March interesting results obtained from a surface examination of mounds in the Middle Euphrates region which throw a light on the comparative ceramics of the æneolithic and Early Bronze periods. The site of the finds, Tell Zeidân, is a mound about 500 metres in length stretching along the eastern bank of the Balîkh river. It is covered with potsherds and flint artefacts, the former being nearly all of a creamy white or light buff, covered with geometric designs in black or reddish brown, applied both with and without a slip, in the former case on the buff ware. Only one polychrome sherd was found. It showed alternating bands of black and brownish red on a white slip over a light buff paste. The result of a comparison of this pottery with that from Abû Shahrein, Tell el 'Obeid, and other sites in which the proto-Mesopotamian ware has been found, and a study of the material as a whole, suggests a similarity, which almost amounts to an identity, in all the pottery from north-western Mesopotamia, Babylonia, and southern Susiana in the pre-monumental age. Its place is taken by incised ware in the third millennium. A possible dating may be given by taking Susa I. as falling in the first half of the fourth millennium, Tell Zeidân about the middle, the early occupation of Eridu and Tell el 'Obeid as slightly later, and the painted ware of Kerkut as belonging to the second half of the fourth millennium.

YOUNG FISHES.—The literature on the behaviour of aquatic animals by day and night receives a contribution from Dr. A. C. Johansen, who discusses the diurnal vertical movements of the young of some fishes in Danish waters (*Meddelelser fra Kommissionen for Havundersogelser. Serie Fiskeri* Bd. 8, Nr. 2, 1925). Dr. Johansen produces observations obtained from catches made with a stramin ring-trawl. The paper contains results of a serial collection taken every two hours throughout the twenty-four on April 20-21, 1925, in the southern Kattegat, and a comparison of a number of hauls taken at different stations in the Kattegat, Belt Sea, and western Baltic in the same month by day and night. Two water-layers were sampled, the surface and an intermediate layer estimated as being at a depth of about 16 metres. The catches showed that the average number of post-larvæ of any one species caught was greater at night than in the daytime in the upper water layers, and the same held good for the number of fish species. This demonstrates the necessity for stating the time at which hauls are made when studying the horizontal and seasonal distribution of young fish The writer considers that, at any rate for the smaller stages, the results represent an actual migration from deeper layers at night, and that in the day-time the majority keep down below 16 metres; but that for the larger more swiftly moving forms, there is a probability that they can avoid the net in the daylight, so that no definite conclusions can be drawn. A short report is given of the plankton results obtained, and also of previous work and theories as to causes of vertical migration. Perusal of this paper only emphasises the need for more observations at sea.

THE FAUNA OF SARAWAK.—The *Sarawak Museum Journal* for December 1925 is devoted to a series of papers describing the collections made by Dr E. Mjöberg in northern Sarawak. It is a region which affords great opportunities to the biologist, and the fact that the collections include many new species is to be expected from a part of the world so little explored. Among the insects, Dr. H. H. Karny reports on the katydids (Tettigoniidæ), cricket-locusts (Gryllacridæ), and Copeognatha. Dr. R. Hanitsch, in dealing with the Blattidæ, lists no less than 55 species, among which 24 are described as new to science: perhaps the most interesting feature with respect to this family is the almost entire absence of cosmopolitan forms—a fact probably associated with the absence of the white man in the region concerned The Collembola form the subject of a paper by Dr. H Schott and, with one exception, all the 12 species recorded by him are new, and three new genera are also erected. The Amphibia and Reptilia from Mt Murud comprise only 14 species, and of these, five are described as new by Mr. Malcolm H. Smith The discovery of a new lizard allied to Phoxophrys is of particular note, as is also that of a tree-frog (*Philautus mjöbergi* sp nov.) which was found depositing its eggs and breeding in the pitchers of Nepenthes. In a second paper Mr. Malcolm Smith reports on the more extensive collections made over a wider area of Sarawak during the past two years. They comprise some 700 specimens representing 95 species. The most noteworthy are a diminutive form of toad allied to Megalophrys, which appears to represent a new genus, and an undescribed ground-gecko of the genus Gonatodes. There are two short notes on birds: Dr. E. Hartert describes a peculiar form of flycatcher, and Mr. Einar Lönnberg directs attention to an apparently new race of flowerpecker.

ANATOMY OF HENDERSONIA.—Mr. H. Burrington Baker has been studying and gives a minute description of the anatomy of *Hendersonia occulta* (*Acad. Nat. Sci. Philad.*, 77), which he considers to be the most primitive living example of the family Helicinidæ. His conclusion is based on the fact that

Hendersonia retains a right auricle and a metamorphosed right kidney in both sexes. With respect to the first of these characters, Hendersonia is fully as generalised as any neritid, while as to the second it seems even less specialised. The Neritidæ cannot be considered as in any sense ancestral to the Helicinidæ, although their aqueous habitats have permitted them to retain certain markedly primitive characters, while the terrestrial life of the Helicinidæ can be correlated with an increase in specialisation along several lines. While the homologies between the Rhipidoglossa and the Pulmonata are extremely hypothetical, the genitalia of Hendersonia and the Helicinidæ perhaps can be tentatively regarded as representative of an intermediate stage between those of the less specialised members of the former group and those of the latter. Both the Helicinidæ and the Pulmonata show a marked tendency towards the concentration of the cerebral, pleural, and, to some extent, the pedal ganglia. The nervous systems of these two pulmonate groups actually prove the more usual conception of separate evolutions from common, probably marine, ancestors.

A Bot-Fly Parasitic on Monkeys.—Under the title *Zoopathologica*, the New York Zoological Society has recently established a journal devoted to the publication of its scientific contributions dealing with animal diseases. In vol. 1, No. 7 (January 1926), Messrs. R. C. Shannon and C. T. Greene record the occurrence of larvæ of Cuterebra in certain primates. One lot of material consisted of the neck portion of the skin of a howling monkey (*Alouatta palliata inconsonans*) from Darien, Panama. It was so heavily infested with larvæ that the skin is described as resembling a collection of cells in a bumble-bee's nest. The other lot of material consisted of two bred flies and a number of larvæ taken from a red howling monkey at Kartabo, British Guiana. Probably all the material belongs to the same species of Oestridæ which is described as *Cuterebra baeri* sp. nov. from that obtained at Kartabo. Little is known of the habits of Cuterebra, but, from what is known, the eggs are probably laid about the haunts of the hosts, possibly on the leaves of the plants. It is suggested that if the leaves be eaten by the host animal, the larvæ hatch in the mouth and, boring their way through the tissues, eventually reach the skin of the throat region. Here they make breathing holes and remain in subcutaneous pockets until fully grown. When mature they work their way out and fall to the ground where they pupate.

Fertilisation in a Cycad.—Prof. A. Anstruther Lawson, of the University of Sydney, publishes in the *Transactions of the Royal Society of Edinburgh* (vol. 54, part 2, No. 6, 1926) a most interesting account of the processes preceding, accompanying, and following fertilisation in the cycad genus Bowenia. This Australian cycad has not been readily accessible to botanists, but the selection of the district in which the plant is native as a centre for fruit-growing, has enabled Prof. Lawson to obtain an uninterrupted supply of cones, collected twice weekly throughout the year. The result is a very full account of the cytology of the reproductive organs and of the process of fertilisation. The massive sperms, with spiral ciliated band bearing thousands of cilia, have actually been seen moving in living material, as they swim in the archegonial chamber. Prof. Lawson describes the dilated neck cells of the archegonium as excreting a fluid which adds to the liquid in which the sperms are moving, and also as acting as 'swinging gates,' which are forced apart by the entrance of the sperms, to close again behind them. Interesting figures of nuclear structure following fusion also suggest that the chromatin of the male and female nuclei remains distinct; the spindle in the first division after fertilisation is a broad one of double organisation, maternal and paternal chromosomes dividing and separating independently.

Flow of Swedish Rivers.—In Band 3, No. 5 of *Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt*, Dr. G. Slettenmark gives a mass of data on the flow of the chief Swedish rivers, illustrated by a map showing the location of the gauging stations. The first table gives a list of the 187 stations, the area of the lake basins on the river, and the total area of the river basin. This is followed by tables giving the mean and extreme value of the flow during each month of the year and other useful values calculated from these figures. Many of the stations date back to 1910, but others are of more recent origin. The publication affords exhaustive information on the hydrography of the Swedish river systems. The very brief discussion of the data is in Swedish.

Does a Faraday Cylinder measure Electron Currents?—We have grown so accustomed to measure electron currents by means of a Faraday cylinder through a hole in which the electrons entered, that a short note in the January issue of the *Proc. Nat. Acad. of Sci.*, Washington, throwing doubt on such measurements, is somewhat disconcerting. It is by Mr. E. O. Lawrence, a National Research Fellow working at Yale University under Prof. Swann, and gives an account of measurements of the currents entering a Faraday cylinder 2·2 cm. diameter through a hole of 1 cm. diameter when the length of the cylinder and the accelerating or retarding potential between the tungsten filament emitting the electrons and a plane anode between the filament and cylinder were varied. The anode was placed 4 cm. from the filament and the electrons passed through a hole 0·2 cm. in diameter in it. Curves of current received in terms of the retarding potential and length of cylinder show that a Faraday cylinder does not retain all the electrons which enter it, and it follows that measurements of the speeds of electrons depending on retarding potential observations require revision.

Soap-Boiling Process.—A further contribution to the knowledge of the equilibria underlying the soap-boiling processes has been made by J. W. McBain and W. J. Elford by a study of the potassium oleate–potassium chloride–water system, described in the *Journal of the Chemical Society* for February. The solutions were examined in polarised light, and from the results, equilibrium diagrams for the systems water–potassium oleate and water–potassium oleate–potassium chloride were constructed, clearly showing the limits of existence of the various soaps.

Vapour Pressures of Arsenic Trioxide.—The determination of the vapour pressures of arsenic trioxide up to 500° C. made by E. R. Rushton and F. Daniels, is described in the *Journal of the American Chemical Society* for February. The apparatus consisted of an evacuated Pyrex flask, fitted with a Gibson diaphragm and heated electrically in a metal bath. The published data include the melting and transition points, heats of fusion, vaporisation, and transition of the various allotropic forms of arsenic trioxide. The exact relation between the amorphous glassy form and the crystalline forms has always been rather obscure, and it is to a large extent cleared up by this work.

The Geographical Distribution of Fresh-water Eels.

THERE is scarcely anything in Nature more wonderful than the facts concerning the migrations and life-histories of the fresh-water eels of Europe and America brought to light by the long and persevering researches of Dr. Johannes Schmidt. He has now completed a general survey of what is known concerning the distribution of all the species of the genus Anguilla The first part of this survey, including only the Atlantic Ocean and adjacent areas, was published sixteen years ago The memoir under notice[1] is the second part and is devoted to the Indo-Pacific region, but it contains certain important additions to the information contained in Part I., and references to the chief general conclusions of that part.

The species of Anguilla seems as a rule to be geographical species, though in some cases two or more occur in the same locality. In the Atlantic region there are only two, *A. vulgaris* on the eastern side, *A rostrata* on the western, the former having a larval period of three years, the latter of only one year. Dr Schmidt tells us that in the Indo-Pacific region, at the beginning of his inquiry, the determination of species was generally uncertain, the distribution obscure, and the biology altogether unknown. Some of the uncertainty with regard to species has been remedied, but the thorough investigation of the bionomics still remains for the future

The world distribution of the whole genus shows some curious features. In the Atlantic the contrast is between north and south. On the eastern side eels are found on all the coasts of Europe and North Africa from near the Tropic of Cancer to the White Sea, including all the Mediterranean and Black Seas and the Baltic On the east side, the range of the American species extends from Labrador to the West Indies, and includes a short stretch of the South American coast at the mouth of the Orinoco. No eels occur on the east coast of South America south of this part, or on the west coast of Africa south of the Tropic of Cancer.

In the Pacific, on the other hand, there are no eels on the east side at all from Alaska to Tierra del Fuego, while on the west they are found, often in great abundance, from Japan along the coast of China, in the Philippines, on the northern coast of New Guinea, the east coast of Australia, in both islands of New Zealand, and in nearly all the western islands of the Pacific. From the Sandwich Islands and the Galapagos farther east they are absent.

Eels occur on most of the coasts of the Indian Ocean, except the Arabian Sea and the south-west coast of Australia. With the exception of the short extent of coast from the north of Norway to Archangel, and an unimportant occurrence in Greenland, there are no eels in the Arctic or Antarctic regions. Another curious contrast is the entire absence of these fish from the shallow sea (less than 100 fm.) bounded by Siam, the Malay Peninsula, Sumatra, Java, and Bor while they pass in very large numbers over the at a similar depth on which the British Islands situated. Dr. Schmidt concludes that the ee immigrating from the depths of the ocean are, in case of the Indo-Malayan species, inferior in migra powers to those of the Atlantic species. Eels do migrate through shallow sea-areas in the larval st but only after the metamorphosis, when they reached the elver stage

Although eels are so abundant in individual temperate regions, the greater number of spe belong to the tropics, and Dr. Schmidt believes the genus originated somewhere in the equato Pacific, and that the species have radiated out f this centre. The most widely distributed of tropical species seems to be *A. mauritiana*, wh occurs in the islands off the east coast of Africa, in Philippines, and in many of the islands of the Pac In the Philippines it reaches a large size, some sp mens measuring 2 m. in length and 46 cm. in circ ference. The oceanic larva or leptocephalus of species was obtained and identified by Schmid Celebes in 1925. The ascent of great swarms of el from the sea to fresh water seems to be as famili sight in Japan as in Europe, and to occur at ab the same time of year.

Apart from Europe and North America, Japa the only country where eel fisheries have develo to a large and important industry. In New Zeal two species have been distinguished, *A. australis* *A. aucklandi*, and specimens occur up to 6 ft length, 20 in. in circumference, 46 lb. in wei They are used as food only to a slight extent by European inhabitants, but are caught and eate considerable numbers by the Maoris

The memoir concludes with a section enti "General Observations," in which the author cusses the probable life-history of *A. japonica*, the absence of a species of eel on the eastern sid the Pacific. He considers that the Japanese resembles the American *A. rostrata*, having a la period of about one year, and spawning in the re of the ocean to the south of Japan, where the t peratures at 400 m. are higher than elsewhere in North Pacific. He suggests that the reason for absence of eels on the eastern side of the Pacific is absence of a species having a larval life sufficie prolonged to enable it to make the long migra from the same spawning region to the eastern sid that ocean, since both *A. rostrata*, the Ameri species, and the *A. vulgaris* of Europe, have b shown by Schmidt to carry on their reproductio the western part of the North Atlantic. This d not, however, explain the absence of eels from b the east and west shores of the South Atlantic.

Like other publications of Dr. Schmidt on researches into the characters and bionomics of fre water eels, this memoir shows his mastery of subject, his command of the English language, his skill in clear and orderly statement.

J. T. C

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[1] On the Distribution of Fresh-water Eels (Anguilla) throughout the World. II. Indo-Pacific Region A Bio-geographical Investigation. By Johs Schmidt. *Mém. de l'Akad. Roy. de Danemark. Section des Sciences,* 8me série, t. 10, No 4.

The Construction of Regular Polygons.[1]

JUST as the sequence of propositions arranged by Euclid to form the first book of his "Elements" reaches its climax in the proof of Pythagoras's theorem, so those in the three succeeding books culminate in the construction of a regular pentagon. In the eyes of the Pythagorean school of Greek mat matics, the five regular solids were considered to symbols of perfection. So one of the aims of the f four books of the "Elements" was to supply accep reasoning that would lead to the construction regular polygons of three, four, and five sides— only ones which can be the faces of a regular solid

No further advance in the theory of construct lar polygons was made until the time of Gauss, at the end of the eighteenth century, showed the construction of a regular p^m-sided polygon, ing prime, depends on a succession of algebraic tions the degrees of which are the prime factors $^{-1}(p-1)$ Any quadratic equation being solved he intersections of a line and a circle, it follows a regular polygon of 2^m+1 sides, when this ber is prime, can be constructed by Euclidean ietry. The chain of quadratic equations leading he value of $\cos(2\pi/17)$ in radicals was fully ssed by Gauss ("Disq. Arith," § 354). Various rs have dealt with the geometrical construction regular 17-gon, and it seems unlikely that any ovement in Richmond's construction (Hudson's ler and Compasses," p. 34) will be possible. elot (*Crelle's Journal*, Bd. 9) dealt with the ence of seven quadratic equations which give $2\pi/257$) in radicals, and the same problem has treated geometrically by Affolter and Pascal *oli Rendiconti*, 1887). Euclid's argument which to the construction of a regular quindecagon e extended to apply to regular polygons of 680 55 × 256 × 257 sides, so, in theoretical discussions, ufficient to consider regular polygons of p^m sides.

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[1] "The Scientific Construction of the Regular Heptagon with Angles Correct to Ten Seconds, derived from Two Crossed-Parallelograms of a Semi-Ellipse." By T. Alexander.

ere are at least three methods of approximately ructing a regular polygon of any number of sides uclidean geometry. First, since

$$\frac{1}{n}=\frac{a_1}{2}+\frac{a_2}{2^2}+\ \ldots\ +\frac{a_m}{2^m}+R_m,$$

$a_r=0$ or 1 and $0<R_m<2^{-m}$, an angle $2\pi/n$ e constructed by m repeated bisections of a angle with an error less than $\pi/2^{m+1}$ Bisection ry small angles can be avoided by a rearrange- of the expansion for $1/n$

second method depends on the formula

$$b^2+c^2-a^2=2bc\cos A,$$

equivalent one, in which appropriate rational s of a, b, c render $A\sim 2s\pi/n$ as small as may be d. Until data are available an element of e enters into the application of this process, being no rule for obtaining *small* rational values b, c to give A within a prescribed limit of error $/n$.

the third method a diameter AOB of a circle, r, is divided into $n-1$ equal parts at points of K is the second from B. Then C being a point e perpendicular diameter such that $OC=\frac{1}{2}\pi r$, uts the circle at Q (beyond the diameter) and $=\alpha=2\pi/n$ with an error of the order $1/n^2$. A more accurate construction is given by

$$KB=4r/(n-\tfrac{1}{2}\pi^2+4)=4r/(n-0\cdot 93),$$

the discrepancy in α then being comparable with $1/n^3$. (A curious but widespread fallacy, of which it would be interesting to know the origin, is that, in the same figure,

$$OC=r\sqrt{3},\quad OK=r(n-4)/n.$$

This rule does not even give a good approximation to a regular figure, the error in α being about 10 per cent when n is large. A much better approximation, avoiding the introduction of π, is given by

$$OC=\tfrac{1}{2}(\sqrt{2}+\sqrt{3})r,\quad OK=r(n-5)/(n-1),$$

this reducing the error in α to ½ per cent. for sufficiently large values of n)

When n is such that the ruler and compasses allowed by Euclid fail, the vertices of a regular n-agon inscribed in a circle can always be obtained as the intersections of algebraic curves with the circle. The curve used to deal with an algebraic equation of degree q, a prime factor of $p^{m-1}(p-1)$, should be one which can be constructed by some simple mechanical means and crosses a curve already drawn in q new points. A cubic equation being always soluble by the intersections of a conic section with a circle, one conic, combined with ruler-compasses geometry, is sufficient when $n=7, 9, 13, 97, 193$, whereas two conics are needed for $n=19, 27, 37, 73$ and three when $n=81, 109$ A suitable conic is an ellipse the foci and major axis of which can be constructed by Euclidean geometry, the usual string and pins process then being available.

Prof. Alexander, in the pamphlet now before us, attempts to construct a regular heptagon, and a reviewer must examine what success has attended his effort In the first place, his constructions, all of which require intricate figures, are approximate · a more accurate approximation to $2\pi/7$ could cer tainly be obtained by drawing a triangle with sui able rational sides a, b, c. Secondly, one constr tion involves the use of a point P on an ell [illegible] such that $\angle PAA'=2\angle PA'A$, A and A' being [illegible] foci: this point P is not defined as the interse of the ellipse with a line or a circle Thirdly, [illegible] most accurate construction, two ellipses are ne to give an approximate value of the angle of a reg heptagon, whereas one ellipse combined with [illegible] and compasses should give the vertices of the hepta exactly. So, for three distinct reasons, we are una to accept Prof. Alexander's constructions as the fin word on the question of the regular heptagon

W. E H. B.

The Malthusian Principle and Sociology.[1]

E variations of the birth rates and death rates in the different countries are most easily studied the diagrams made of them by Dr. C. V iale, the president of the Malthusian League rates remained high, except in France and d, until 1876. Then the birth rate of England, um, Holland, Germany, Austria, and Switzer- and of Europe as a whole, suddenly began to This sudden onset of declining fertility must been due to contraception. The death rates ith the birth rates, and in such close corre- ence as to show that the fall of the death rates losely related to the fall of the birth rates. the progress in medical science and sanitation d the death rates in such close parallelism he birth rates can scarcely have been a co- e. Moreover, when one examines the vital statistics of Rumania, Chile, and Jamaica, and of Russia from 1881 to 1901, and of Ireland from 1886 to 1911, one finds a horizontally-oscillating or fairly stationary birth rate and a similar death rate. Why were not medicine and sanitation reducing the death rate of any of these countries when their birth rate was stationary? Furthermore, Bulgaria, Ceylon, and Japan had a rising birth rate and a rising death rate from 1881 to 1911 Why did these countries then have a rising death rate notwithstanding medical progress?

Evidently, as Malthus believed, the populations of all the long-settled countries were pressing on their means of subsistence—that is, were not increasing their food supplies fast enough for their needs. For example, consider England In 1876 the birth rate and death rate were still very high and the average duration of life only about thirty-five years. Then the birth rate fell or new mouths were added more slowly, and there steadily declined the proportion of persons dying prematurely from diseases consequent upon under-nutrition, thus the death rate fell steadily and the average duration of life rose. The under-nourished are doomed to premature death no matter how efficient and active the health services may be; nothing can make a population increase faster than the food supply; if there be ten additional persons, and only food for eight, two must soon die. The high correlation between the birth rate and the death rate continued up to 1913; therefore, food shortage was still the cause of what was excessive in the death rate up to 1913. Thus the whole of the fall of the death rate from 1876 to 1913, the big reduction of poverty, and the rise in the average duration of life from about thirty-five years to more than fifty years, must be attributed to the decline of the birth rate steadily reducing the amount of the food shortage.

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[1] ract of a paper read by Mr. Binnie Dunlop, M.B., on February 23, ociological Society.

In all the other old countries, and not excluding France, one may similarly infer that up to 1913, notwithstanding the extent to which the birth rate had fallen in some of them, the population was still pressing on the means of subsistence. The main conclusion is most encouraging and is as follows: Virtually the sole economic difficulty which besets man is that he can only increase his food supply very slowly; consequently, small families and willing work would eliminate poverty.

University- and Educational Intelligence.

CAMBRIDGE.—The Allen Scholarship has been awarded to Ralph Cooper, of Trinity College.

The list of those who have recently passed the qualifying examination (in elementary mathematics and mechanics) for the Mechanical Sciences Tripos hows that twenty-three per cent. of those who were uccessful had not yet come into residence The rriculum for this examination can usually be dealt h at school, and it is of some satisfaction to realise the slow but steady rise in the standard attained e schools is gradually relieving the university of ad of elementary teaching, for which it is often oo well equipped, and with which it really ought o be encumbered

Alfred and Lady Yarrow have offered to ow an Eric Yarrow lectureship for the study of syriology.

Dr. D. Stockdale, of King's College, has been elected a fellowship at that College. He has taken both parts of the Natural Science Tripos and was elected to a Senior "1851 Exhibition" studentship in 1923

MANCHESTER.—The following have been recommended for the honorary degree of D.Sc: Mr. S. L. Pearce, Electricity Commissioner, formerly Consulting and Chief Engineer and Manager, Electricity Department, Manchester Corporation; Prof. A. C. Seward, Vice-Chancellor of the University of Cambridge, professor of botany there; Dr. A. E. H. Tutton, formerly H.M. Inspector of Schools (Technological Branch), Board of Education.

THE British American Tobacco Co., Ltd., has sent a donation of 105*l*. to the funds being collected for the development of the Imperial College of Tropical Agriculture, Trinidad. Other recent donations and promises include 250*l*. from The Manchester Cotton Association, Ltd; 105*l*. each from the Royal Mail Steam Packet Co., Ltd., and Messrs. Alfred Holt and Co.; and 100*l*. each from Lord Queenborough, M.P., and C. H. Gray, Esq. These donations, together with the sum of 15,000*l*. recently granted by the Imperial Government, will be devoted to the building of a hostel for the students, and the provision of an e
where the business side of farming may be ta
A further 25,000*l* is, however, still urgently requ
Contributions may be sent to Mr. Algernon Asp
Secretary, 14 Trinity Square, London, E.C.3,
Barclays' Bank (Dominion, Colonial, and Overs
30 Gracechurch Street, E.C.3.

WIDESPREAD interest will be aroused by
publication of the report of the Departmental
mittee on the University of London (H.M.S.O.
2612). This Committee was asked to conside
final (1913) report of the Royal Commissio
University Education in London, and to
recommendations as to changes in the constit
of the University which may now be desirable.
terms of reference were wide, and the Committ
its discretion, decided to make no recommenda
on the questions of the site of the University
the external examination system. One of the
recommendations is that a council of sixteen sh
have the final control of finance, if and whe
Senate approves of the educational policy im
Nine of the sixteen are to be University repres
tives—the chancellor and the chairman of Con
tion, the vice-chancellor and six others from
Senate; four will be nominated by the Crown
two by the London County Council; one w
co-opted As regards the constitution of the Se
it is suggested that the present 'nominated t
should be replaced by a collegiate council cons
of the vice-chancellor and the principal of the U
sity, and the heads of the seven chief school
colleges, together with two representatives o
medical schools, and a few others representing
schools. The chief function of this council w
the supervision of inter-collegiate affairs. The
membership of the Senate is to be reduced
56 to 49.

UNIVERSITY COLLEGE, Reading, has now rec
its Royal Charter conferring upon it the full
of a university. This was announced on Satu
March 20, by Mr. H. G. Williams, M.P., who
gratulated the Lord-Lieutenant of Berkshire, Mr.
Benyon, on becoming the first chancellor.
latest addition to the family, now numbering
of twentieth-century universities of Englan
descended from "The University Extension Co
in conjunction with the Schools of Science and
Reading," which was opened in 1892 and incorpo
under the Companies Acts in 1896. Of its
universities the youngest is Bristol, charter
1909. The University has an endowment of 285,
of which 200,000*l*. came from the Palmer famil
50,000*l*. from Lady Wantage. The first pri
was Mr. H. J. (now Sir Halford) Mackinder, t
student on the foundation of Christ Church, O
The present principal, Mr. W. M. Childs, has
office since 1903. There are a strong facul
agriculture and horticulture, and departmen
fine arts, music, and domestic subjects, in ad
to faculties of letters and science. The Na
Institute for Research in Dairying forms part
University. The number of full-time studen
shown in the University Grants Committee's r
for 1923-24 is 578, distributed as follows: Ar
(including 287 women), pure science 104, agric
135. A cardinal principle of the policy of the C
from its earliest years has been to stress th
portance of the corporate life of its members.
is reflected in the large proportion (70 per ce
its full-time students in halls of residence.
modern English and in Scottish universitie
majority of the students reside in lodging
home.

Contemporary Birthdays.

March 27, 1844.	Maj.-Gen Adolphus W. Greely.
March 27, 1857.	Prof Karl Pearson, F R S
March 27, 1855.	Sir J. Alfred Ewing, K.C.B ,F.R.S.
March 29, 1840.	Sir John Scott Keltie.
March 29, 1853.	Dr. Elihu Thomson.
March 29, 1860.	Prof. William B. Benham, F R S.
March 31, 1890.	Prof .William L. Bragg, F.R.S.
March 31, 1854.	Sir Dugald Clerk, K B E., F R S
March 31, 1870.	Sir William J. Pope, K B E. F.R.S.
March 31, 1859.	Sir Frederick W Andrewes, F.R S.

Maj.-Gen GREELY, polar explorer and telegraphist, was born at Newburyport, Mass. He served in the Civil War, 1861–65, and, we believe, was the first volunteer private soldier to reach the grade of brigadier-general, U.S.A. In 1881 he was placed in command of the United States official expedition to establish one of a chain of thirteen circumpolar stations, his party of twenty-five reached farther north than any previous record, discovered new land north of Greenland, and crossed Grinnell Land to the Polar Sea. The final story of the Greely Expedition was one of disaster · there were only seven survivors General Greely was the United States delegate at the International Telegraph Conference, London, 1903 Under his supervision 3900 miles of telegraph lines, submarine cables, and wireless were installed in Alaska, 1900–4.

Prof. KARL PEARSON was educated at University College School, London, and King's College, Cambridge. He was called to the bar, Inner Temple, 1882. Galton professor of eugenics in the University of London, and editor of *Biometrika*, he has written many memoirs on the mathematical theory of evolution and on heredity.

Sir ALFRED EWING, president of the Royal Society of Edinburgh, was born at Dundee. Formerly professor of mechanism and applied mechanics in the University of Cambridge, he was afterwards (1903–16) Director of Naval Education. Since then he has been Principal and Vice-Chancellor of the University of Edinburgh. He was awarded a Royal medal by the Royal Society, in 1895, for researches on magnetic induction in iron and other metals.

Sir JOHN SCOTT KELTIE was educated at Perth, and the Universities of St. Andrews and Edinburgh. For a number of years he was assistant editor of NATURE Sir John was secretary of the Royal Geographical Society, 1892–1915

Sir DUGALD CLERK was born in Glasgow. He is universally known as an investigator in the problems of internal combustion engines. The Albert medal of the Royal Society of Arts was allotted him in 1922, "in recognition of contributions . . . to the development of the internal combustion engine, which in its latter forms has rendered aerial navigation possible, and is also extensively employed in the motor-car and in the submarine." Sir Dugald was a Royal medallist of the Royal Society in 1924.

Sir WILLIAM POPE, professor of chemistry in the University of Cambridge, is a Londoner. He was educated at Finsbury Technical College and the Central Technical College, City and Guilds of London. After a professorial career at the University of Manchester, he became head of the Chemistry Department, Goldsmiths' Institute, New Cross. Sir William was Longstaff medallist of the Chemical Society, 1903, and Davy medallist, Royal Society, 1914.

Societies and Academies.

LONDON

Royal Society, March 18 — **S Chapman**, **J. Topping**, and **J Morrall** : On the electrostatic potential energy, and the rhombohedral angle, of carbonate and nitrate crystals of the calcite type Calculations have been made of the electrostatic potential energy of ionic lattices of the calcite type and for the sodium nitrate crystal, in which the lattice is of the same geometrical type, though the ionic charges are different. It seems probable that, owing to the fourfold positive charge in the C ions, the O ions of the CO_3 group will be distorted from their natural symmetrical form, and consequently the electrostatic centre of the O ion will be nearer to the C nucleus than the O nucleus is The calculations indicate that the electrostatic centre of the O ion is 0·9 Å U distant from the centre of the C ion, compared with the value 1·25 Å U given by X-ray measurements for the distance between the O and C nuclei. A similar result is obtained for $NaNO_3$. — **G I. Finch** and **L G. Cowen** : Gaseous combustion in electric discharges. Pt. I. Steady direct current electric discharges are passed through electrolytic gas at 20–100 mm pressures, and the rate of steam formation measured for varying conditions It is found that the rate of combustion is determined only by the current, and up to a certain limiting current, combustion is confined to the cathode zone, depends upon the cathode material, and is directly proportional to the current. On exceeding this limiting current, combustion commences *abruptly* in the inter-electrode zone and is superposed upon cathodic combustion. This inter-electrodic combustion is also proportional to current, but, unlike the cathodic, is independent of the electrode material, and dependent upon gas pressure and separation of the electrodes. Little or no combustion takes place in the anode zone. Combustion seems to be primarily determined by ionisation of the gaseous medium for the current. The abrupt superposition of inter-electrodic combustion suggests a quantum effect, combustion in the inter-electrode zone depending upon a certain limiting potential fall being attained — **C N. Hinshelwood** and **W K Hutchison** : A homogeneous unimolecular reaction the thermal decomposition of acetone in the gaseous state. The temperature range used was 506° to 632° C. The heat of activation is 68,500 calories, and the results can be summarised by the equation $l_e k = 34{\cdot}95 - 68{,}500/RT$. Calculation shows that the number of molecules reacting per second is about 10^8 times greater than the maximum number that could be activated by collision. The absolute rate at 835° Abs is the same as that of the nitrogen pentoxide decomposition at 328° Abs — **H. Lamb** : On wave resistance. The case considered is that of a solid of dimensions small compared with the depth below the free surface, travelling horizontally under water. Various particular cases of this have been worked out. There appears to be room for a more general investigation in which no assumption is made as to the form of the solid. The device employed for calculation of the resistance is to introduce small frictional forces, and to equate the work done against resistance to the dissipation of energy — **C. E. Eddy** and **A. H. Turner** : The *L* emission series of mercury. — **G R. Goldsbrough** : The properties of torsional vibrations. In order to bring out clearly the nature of the torsional vibrations in reciprocating engine shafts, a simplified model is chosen which emphasises the main characteristics. Even when friction is great, there are two critical speeds of shaft rotation corresponding to each term in the externally applied force.—**E. T. Hanson**: The theory of ship waves. The oscillations of a fluid under gravity, when the depth is variable or very great, have been worked out in two special cases. The theory is now extended very generally to cover a series of cases in which the fluid may be treated as a sea, bounded by a sloping shore on one side and extending indefinitely on the other. It is shown that, whenever the inclination of the shore to the horizontal is a submultiple of a right angle, the problem can be completely solved, and in each case there is a doubly infinite number of possible modes of motion under gravity. This extension makes it possible to calculate the precise effect of a sloping shore upon the formation of the beautiful wave pattern which often follows in the wake of a ship.—**A. O. Rankine**: The effect of temperature on the viscosity of air. The values of the viscosity of air obtained by Williams (*Roy. Soc. Proc.*, A, vol. 110, p. 141) in the lower part of the temperature range are seriously in error. The conclusion that Sutherland's law of the variation of viscosity with temperature becomes invalid for air at the relatively high temperature of 250° C is not justified.

Geological Society, February 24.—**Gertrude Lilian Elles**: The geological structure of Ben Lawers and Meall Corranaich (Perthshire). The country dealt with lies between Loch Tay on the south and Glen Lyon on the north, and between the Loch Tay fault on the east and the Ericht-Laidon-Tyndrum fault on the west. The line of junction between the Ben Lui schists and the Ben Lawers schists is a mechanical one of the nature of a folded slide, the Ben Lawers slide, the rocks above this slide constituting a veritable nappe, the Ben Lawers nappe. The metamorphic condition of the rocks indicates that the folding now exhibited by them is a relatively late feature of the structural story, and obscures their original relationships, which seem to demand inversion of the beds on a large scale such as would be brought about by recumbent folding.

Physical Society, February 26.—**A. Ferguson** and **I. Vogel**: On the hyperbola method for the measurement of surface tension. When a liquid lies between two plates inclined to one another at a small angle, its surface has a hyperbolic section, from which the surface tension can be calculated. The method has recently been improved by Grunmach. Errors arise, however, from the difficulty of determining the horizontal and vertical axes of co-ordinates. This is met by plotting two linearly related functions of the observations, the surface tension being deduced from the co-ordinates of the resulting mean straight line and the angle between the plates. The latter may be measured either directly or by calibration with a liquid of known surface tension.—**E. A. Owen** and **A. F. Dufton**: The application of radiography to the study of capillarity. The X-ray shadow of a tube has previously been used for determining the diameter of the bore. A similar method has been used successfully for capillarity measurements, and observations were made of the rise of mercury in copper and steel tubes and between vertical copper plates.

Society of Public Analysts, March 3.—**B. S. Evans** and **S. G. Clarke**: An accurate method for the determination of mercury in solution. The mercury (in solution as mercurous nitrate) is deposited on copper and then sublimed. The mercurous solution is percolated for 1½ to 2 hours through a special apparatus (see below), the filter tube of which contains a layer of copper filings. The copper, with the deposited mercury, is washed with water and then with acetone, and afterwards dried, and the mercury is sublimed on to platinum and weighed. Accurate results are obtained in the presence of arsenic antimony or bismuth, and large amounts of copper and nitrates. Hydrochloric acid interferes with the deposition, and must be removed.—**B. S. Evans**: An apparatus for continuous percolation and for filtration in neutral atmospheres. The liquid is made to percolate through a filter tube, with the aid of pressure or suction, into a flask, an open return tube ensuring that the pressure in the main funnel and the flask is the same. When the liquid in the flask reaches the end of the return tube, a difference of pressure is established and the liquid is driven back to the main funnel. For filtration in an inert atmosphere a cylinder of the desired gas can be used as the source of pressure.—**A. L. Bacharach**: Notes on the determination of moisture, calcium and phosphorus in the bones of rats. Conclusions as to the influence of diet, etc., on calcium and phosphorus metabolism are largely based on analyses of the bones of experimental animals. Standardised methods are therefore desirable; a routine method is described, and attention is directed to several possible sources of error.

CAMBRIDGE.

Philosophical Society, February 15.—**A. V. Hill**: Irreversible phenomena in muscular shortening.

March 1.—**F. A. Potts**: The development of a harpacticid Copepod.—**J. Gray**: The growth of fish during the phase of yolk-sac nutrition.—**J. Needham**: Intracellular oxidation-reduction potential and anaerobiosis. The intracellular oxidation-reduction potential of *Amœba proteus* appears to be widely independent of the external concentration of oxygen. *Nyctotherus cordiformis*, an anaerobic protozoon normally living in the frog's large intestine, possesses an internal *p*H of 7·1 and an internal *r*H of 19·0-20·0 under aerobic conditions, while under anaerobic conditions the latter value changes to *r*H 9·5-10·5. Nyctotherus can therefore reduce strongly electronegative indicators. It is significant that the amœba, the *r*H of which is independent of the environmental oxygen concentration, cannot adapt itself to an anaerobic life and dies in conditions under which Nyctotherus will live.—**Sir J. Larmor**: Insular gravity and oceanic isostasy.—**R. Hargreaves**: (1) Relativity in connexion with axial rotation. (2) The problem of relativity in reference to several bodies.—**R. Vaidyanathaswamy**: The general (m, n) correspondence.—**S. Goldstein**: The stability of a strut under thrust, when buckling is resisted by a force proportional to the displacement.

PARIS.

Academy of Sciences, March 1.—The president announced the death of Prof. Kamerlingh Onnes.—**Gaston Julia**: The domain of existence of an implicit function defined by an integral relation $G(x,y)=0$.—**H. Krebs**: A geometrical representation of some transformations of partial differential equations.—**H. Milloux**: A property of meromorph functions at asymptotic value.—**A. Kovanko**: The necessary and sufficient conditions of the integration of suites of functions capable of summation term by term.—**Edgar B. Schieldrop**: The non-holonome deviation.—**R. Dugas**: The geometrical interpretation of the method of Jacobi in the case of a point of variable mass.—**Louis Roy**: The propagation of waves on the elastic line with six parameters.—**E. G. Barrillon**: A mechanical apparatus for tracing hydrodynamical fields.—Marcel **Jacob**: The utilisation of measurements of rotatory magnetic polarisation in the analysis of mixtures. In order to circumvent the difficulty introduced by unavoidable changes in the intensity of the magnetising current, a compensation method was arranged, details of which are given.—A. **Dauvillier**: Researches on electric discharge in gases and the radiations which accompany it.—M. **Aubert** and E. **Aubrée**: An extension of the method of critical solubility temperatures for the analyses of petrols. The calculations are based on measurements of the critical solubility temperatures of the petrol in two different solvents—aniline and benzyl alcohol.—André **Job** and André **Samuel**: Complexes produced by the oxidation of the nickelocyanides in the presence of hydroxylamine. The violet complex compound produced by the oxidation in air of potassium nickelocyanide in the presence of hydroxylamine can be converted into a blue compound by the action, in neutral solution, of mercuric chloride, one cyanogen group being removed. Probable formulæ for these coloured complexes are discussed.—J. **Bougault**: An ether-oxide example of a ketone hydrate.—P **Billon**: Combinations of oximes with zinc chloride. In the preparation of oximes with Crismer's salt, the zinc chloride is usually eliminated at the conclusion of the reaction by the addition of water. In the absence of water, an intermediate compound containing zinc chloride can be isolated from the reaction between Crismer's salt and a ketone, and these substances in contact with water decompose, giving the oxime and zinc chloride.—Georges **Mouret**: The coal basin of Haute-Dordogne. The exactitude of the results obtained by Amiot in this field is confirmed, the exact extent of the basin defined, and the character of its limits recognised.—A. **Maige**. Variations of the threshold of amylogen condensation in various cells of the plant.—Antonin **Nemec**: The humification of the dead layer of forest soils.—L. M. **Bétances**: The diffuse lymphoid formations of the vertebrates — Auguste **Lumière** and Mme. **Montoloy**: Anthrax infection and immunity by the peritoneum

ROME.

Royal Academy of Lincei, January 3.—O. M. **Corbino**: The electronic theory of thermomagnetic phenomena — Livio **Cambi**: A supposed nitroprusside of bivalent iron Doubt is expressed concerning the constitution of the compound to which Ungarelli recently attributed the formula, $Na_4[Fe(CN)_5 . NO],9H_2O$.—Carlo **Severini**: The convergence of the series of orthogonal functions.—Giovanni **Vacca**: New series for Euler's constant, $C = 0{\cdot}577 \ldots$—Mariano **Pierucci**: The total energy of the planets. The "energies" of the various planets may be obtained from that of Jupiter by dividing by simple powers of the prime factors 2, 3, and 5; the differences between the values thus calculated and those actually observed being of the same order of magnitude as the errors involved in the determination of the masses.—E. **Raimondi**: Transformation serving for the study of a current flowing between a sheet and an indefinite plane wall.—D **Graffi**: Investigations on the accidental birefringence of colloids in movement.—C. **Jucci**: Parthenogenesis in silkworms as an illustration of the physiological capacity of individuals and of the race.—Giulio **Cotronei**: The biology of Petromyzon. (iii.) The phenomenon of contraction in the sexual maturity of *Petromyzon marinus*. The processes of sexual maturity in *P. marinus* are similar to those in *P. fluviatilis* and are also accompanied by contraction.—G. **Fadda**: A case of functional regeneration in *Cyprinodon calaritanus*.

Official Publications Received.

Cincuentenario de la Sociedad Científica Argentina (1872–1922). Evolucion de la Ciencias en la República Argentina. 18: La Evolución de la Meteorologia. Por Guillermo Hoxmark. Pp. 80. (Buenos Aires.)

The British Mycological Society. Transactions, Vol. 10, Part 4. Edited by Carleton Rea and J. Ramsbottom. Pp. 253–344. (Cambridge: At the University Press.) 7s. 6d. net.

República Argentina: Ministerio de Agricultura de la Nación. Oficina Meteorologica Nacional. Boletin Mensual. Año 7, 1922. Pp. 86+62 charts. (Buenos Aires.)

Egyptian Government Almanac for the Year 1926. Pp. viii+324. (Cairo: Government Publications Office.) 5 P.T.

Department of the Interior: United States Geological Survey. Water-Supply Paper 499: The Papago Country, Arizona; a Geographic, Geologic and Hydrologic Reconnaissance, with a Guide to Desert Watering Places. By Kirk Bryan. Pp. xviii+436+27 plates. 85 cents. Water-Supply Paper 532: Surface Water Supply of the United States, 1921. Part 12: North Pacific Slope Drainage Basins B: Snake River Basin. Pp. vi+292+2 plates. 25 cents. Water-Supply Paper 545: Surface Water Supply of the United States, 1922. Part 5: Hudson Bay and Upper Mississippi River Basins. Pp. v+197+2 plates. 25 cents. Water-Supply Paper 556: Water Power and Flood Control of Colorado River below Green River, Utah By E. C. LaRue. Pp. x+176+79 plates. 1 dollar. (Washington, D.C.: Government Printing Office.)

Department of the Interior: United States Geological Survey. Professional Paper 136: The Flora of the Ripley Formation. By Edward Wilber Berry. Pp. iii+94+23 plates. (Washington, D.C.: Government Printing Office) 50 cents.

Sixty-third Annual Report of the Secretary of the State Board of Agriculture of the State of Michigan and Thirty-seventh Annual Report of the Experiment Station from July 1, 1923, to June 30, 1924. Pp. 1030. (Lansing, Mich.)

Agricultural Experiment Station: Michigan State College of Agriculture and Applied Science. Technical Bulletin No. 69: The Fruiting Habits and Pruning of the Concord Grape. By N. L Partridge. Pp. 26. Technical Bulletin No. 71: Growth of Lettuce as influenced by Reaction of Culture Medium. By John W. Crist. Pp 25 Technical Bulletin No. 72: Potato Spraying and Dusting Experiments in Michigan. By J. E. Kotila and G. H. Coons. Pp. 15. Technical Bulletin No. 73: Adsorption by Activated Sugar Charcoal; with particular reference to Adsorption and Soil Acidity. By Elroy J. Miller. Pp. 60. Circular Bulletin No. 70: The Present Status of the European Corn Borer in Michigan. By R. H. Pettit. Pp. 14. (East Lansing, Mich.)

State of Illinois Department of Registration and Education: Division of the Natural Survey. Bulletin, Vol. 15, Article 5: Changes in the Small Bottom Fauna of Peoria Lake, 1920 to 1922 By Robert E. Richardson Pp. 325–388. Bulletin, Vol. 15, Article 6: Illinois River Bottom Fauna in 1923. By Robert E. Richardson. Pp. 389–422. Bulletin, Vol. 15, Article 7: Some Observations on the Oxygen Requirements of Fishes in the Illinois River. By David H. Thompson. Pp. 423–487. (Urbana, Ill.)

Aeronautical Research Committee. Reports and Memoranda, No. 976 (Ae 190): Some Experiments on a Model of a B.A.T. "Bantam" Aeroplane with special reference to Spinning Accidents. Part 1: Longitudinal Control and Rolling Experiments, by H. B. Irving and A. S Batson; Part 2: Experiments on Forces and Moments (including Rudder Control), by H. C. H. Townend and T. A. Kirkup. (A.3 g. Complete Models, 55, a, b, and c.—T. 1982, a, b, and c.) Pp 22+16 plates. 1s. 3d. net. Reports and Memoranda, No. 988 (M. 31): The Air Bubble Viscometer. By Dr. Guy Barr. Pp. 10+2 plates. 9d. net. (London: H.M. Stationery Office.)

Proceedings of the Cambridge Philosophical Society. Vol. 23, Part 1. Pp. 102. (Cambridge: At the University Press.) 7s. 6d. net.

Hull Museum Publications. No. 141: Record of Additions, No. 66. Edited by T. Sheppard Pp. 51 (Hull.)

Leeds University. Twenty-first Report, 1924–25. Pp. 164. (Leeds)

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1925. Pp iv+443+121. (London: H.M. Stationery Office) 12s 6d. net.

Cornell University: Agricultural Experiment Station, Memoir 91: The Relation of Soil Moisture and Nitrates to the Effects of Sod on Plum and Cherry Trees. By T. L Lyon, A J. Heinicke and B. D. Wilson Pp. 31. Memoir 93: A Study of the Oyster-Shell Scale, Lepidosaphes ulmi (L.), and one of its Parasites, Aphelinus mytilaspidis Le B. Part i: Biology and Morphology of the two forms of Oyster-Shell Scale; Part ii: Biology of a Parasite of the Oyster-Shell Scale. By Grace H. Griswold Pp. 67. Memoir 94: Variations within and between Morphological Varieties of Oats and Barley. By R. G. Wiggans. Pp. 36. Memoir 95: An Explanation for the Relative Effects of Timothy and Clover Residues in the Soil on Nitrate Depression. By R. D. Wilson and J K. Wilson Pp 21. (Ithaca, N.Y.)

Carnegie Institution of Washington. Annual Report of the Director of the Laboratory for Plant Physiology. (Extracted from Year Book No. 24, for the Year 1925.) Pp. 137–160 (Washington, D.C.)

Cornell University: Agricultural Experiment Station. Bulletin 439: Rearing Calves by the Use of Calf-Meal Gruel By L. A. Maynard, L. C. Norris and W. E Krauss. Pp. 23 Bulletin 440: An Economic Study of the Marketing of New York Potatoes. By M. P. Rasmussen. Pp. 172. Bulletin 441: Economic Studies of Dairy Farming in New York. 4: Grade B Milk with Cash Crops and mixed Hay Roughage, Crop Year 1921. By E. G. Misner. Pp. 76 Bulletin 442: Economic Studies of Dairy Farming in New York. 5: Cheese-Factory Milk. By E G. Misner. Pp. 50. Bulletin 447: The Effect of some Legumes on the Yields of succeeding Crops. By T. L Lyon. Pp. 20. (Ithaca, N.Y.)

Proceedings of the Ninth West Indian Agricultural Conference, Kingston, Jamaica, January 1924. Pp. 282. (Jamaica, B.W.I.: Government Printing Office.) 2s. 6d.

Western Australia. Annual Progress Report of the Geological Survey for the Year 1924 Pp. 22 (Perth: Fred. Wm Simpson.)

Publikationer fra det Danske Meteorologiske Institut. Aarbøger. Isforholdene i de Arktiske Have (The State of the Ice in the Arctic Seas) 1925 Bearbejdet af (Prepared by) Kaptajn C. I. H. Speerschneider. Pp. 33+5 maps (København: G E. C. Gad.)

Abstract-Bulletin of Nela Research Laboratory, Incandescent Lamp Department, of General Electric Company, Cleveland, Ohio. Vol. 1, No. 4, December 1925. Pp. x+523-746+8 plates. (Cleveland, Ohio.)

Annals of the South African Museum. Vol. 16, Part 2, containing: 2. Contributions to a Knowledge of the Flora of South-West Africa. 1: List of Grasses. By Miss S. Garabedian. Pp. 381-436+plate 8. 4s. Vol. 19, Part 4, containing: 10. New Species of Geometridae (Lepidoptera) in the Collections of the South African Museum, by Louis B. Prout; 11. Mycetophilidae and Bibionidae (Diptera) in the Collections of the South African Museum, by F. W. Edwards; Title, Index, etc., to Vol. 19. Pp. 579-616+xiii+plates 16-17. 5s. 6d. Vol. 20, Part 4, containing: 6. The South African Species of the Molluscan Genus Onchidella, by Hugh Watson; 7. Reports on the Marine Mollusca in the Collections of the South African Museum. 1: Turritellidae, by J. R. le B. Tomlin. Pp. 287-316+plates 27-32. 10s. Vol. 21, Part 1, containing: A Monograph of the Marine Fishes of South Africa. Part 1: (Amphioxus, Cyclostomata, Elasmobranchii and Teleostei—Isospondyli to Heterosomata). By Dr. K. H. Barnard. Pp. 418+17 plates. 25s. Vol. 22 (Descriptions of the Palaeontological Material collected by the South African Museum and the Geological Survey of South Africa), Part 1, containing: 1. On some South African Fossil Woods, by John Walton; 2. Revision of the Fauna of the Bokkeveld Beds, by Dr. F. R. C. Reed; 3. Investigations in South African Fossil Reptiles and Amphibia (Part xiii), by Dr. S. H. Haughton; 4: Notes on some Cretaceous Fossils from Angola (Cephalopoda and Echinoidea), by Dr. S. H. Haughton. Pp. 263+15 plates. 20s. Vol. 23, Part 1, containing: 1. Contributions to a Knowledge of the Fauna of South-West Africa. iv. A List of the Heteropterous and Homopterous Hemiptera of South-West Africa. By Dr. A. J. Hesse. Pp. 190+8 plates. 12s. 6d. (Cape Town: South African Museum; London: Wheldon and Wesley, Ltd.)

Royal Botanic Gardens, Kew. Picture post cards. Set 9: Hardy Trees and Shrubs. 6 cards in colour. 1s. Set 10: Stove and Greenhouse Plants. 6 cards in colour. 1s. Set 11. Rhododendrons (*Ericaceae*). 6 cards in colour. 1s. Set 12: Hardy Trees and Shrubs. 6 cards in colour. 1s. (Kew, Surrey: Royal Botanic Gardens.)

Canada. Department of Mines: Mines Branch. Investigations in Ceramics and Road Materials (Testing and Research Laboratories) 1924. Pp. ii+45. (Ottawa: F. A. Acland.)

Dominion of Canada. Report of the Department of Mines for the Fiscal Year ending March 31, 1925. Pp. ii+75. (Ottawa: F. A. Acland.) 15 cents.

Proceedings of the University of Durham Philosophical Society. Vol. 7, Part 2, 1924-1926. Pp. 59-106. (Newcastle-upon-Tyne.) 5s.

Report of the Broadcasting Committee, 1926. (Cmd. 2599.) Pp. 22. (London: H.M. Stationery Office.) 6d. net.

Report of the Royal Commission on the Coal Industry (1925), with Minutes of Evidence and Appendices. Vol. 1: Report. (Cmd. 2600.) Pp. xii+294. (London: H.M. Stationery Office.) 1s. net.

Proceedings of the Royal Society of Edinburgh, Session 1925-1926. Vol. 46, Part 1, No. 9: The Slow Oxidation of Phosphorus Trioxide. Part 1: The Action of Water-Vapour on Phosphorus Trioxide. By Dr. Christina Cruickshank Miller. Pp. 76-85. 1s. Vol. 46, Part 1, No. 10: Note on Copper-tinted Flame Caps. By William Cooper. Pp. 86-89. 1s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

National Research Council. Organization and Members, 1925-1926. Pp. 59. (Washington, D.C.: National Academy of Sciences.)

XXXIII Jahresbericht des Sonnblick-Vereines für das Jahr 1924. Pp. 34. (Wien: Selbstverlag des Sonnblick-Vereins.)

Tanganyika Territory. Report of the Department of Agriculture for the Year 1924-5. Pp. 45. (Dar es Salaam.)

Agricultural Experiment Station, Kansas State Agricultural College, Manhattan, Kansas. Technical Bulletin 17: Studies of Inheritance and Evolution in Orthoptera. 5: The Grouse Locust, Apotettix eurycephalus Hancock. By Robert K. Nabours. Pp. 231. (Manhattan, Kansas.)

Memoirs of the Geological Survey of India. Vol. 51, Part 1: Indian Geological Terminology. By Sir Thomas H. Holland. Pp. iv+184+xx. (Calcutta: Government of India Central Publication Branch.) 2 8 rupees; 4s. 6d.

Verhandlungen des Naturhistorischen Vereins der preussischen Rheinlande und Westfalens. Zweiundachtzigster Jahrgang, 1925. Pp. xii+456+7 Tafeln. (Bonn.)

Report of the Twenty-third Annual Meeting of the South African Association for the Advancement of Science, Oudtshoorn, 1925, July 6-11: Being Vol. 22 of the South African Journal of Science. Pp. xlv+579+21 plates. (Johannesburg.) 30s. net.

Scientific Papers of the Institute of Physical and Chemical Research. No. 41: On the Separation of Germanium. By Isaburo Wada and Sechi Kato. Pp. 243-261. 30 sen. No. 42-43-44: Synthesis of the simplest Homologue of Urushiol, by Sin-iti Kawai; On a new Reaction between Triacetine and Phenol and an improved Method for the Preparation of Triacetine, by Sin-iti Kawai; On the Preparation of Catechol-Ortho-Carboxylic Acid and the Condensation between Catechol and Glycerol, by Sin-iti Kawai. Pp. 263-281. 30 sen. No. 45: The Effect of Atmospheric Humidity on the Dielectric Losses and Power Factors in Fibrous Insulating Materials. By Shoji Setoh and Yotsuo Toriyama. Pp. 283-322. 50 sen. No. 46: On the relative Nutritive Value of various Proteins contained in Japanese Food Articles. By Umetaro Suzuki, Yoshihiko Matsuyama and Nabetaro Hashimoto. Pp. 47. 60 sen. No. 47: The Crystal Structure of Iodoform. By Isamu Nitta. Pp. 49-58. 30 sen. No. 49: Radioactive Manganiferous Nodules from Tanokami, Oomi Province. By Satoyasu Iimori. Pp. 79-82. 30 sen. (Tokyo.)

The New University of Reading: some Ideas for which it Stands. By W. M. Childs. Pp. 64. (Reading.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 66: Seasonal Variation in Salinity of Water of some Drains of the First Circle of Irrigation. By R. Aladjem. Pp. 4+5 plates. (Cairo: Government Publications Office.) 5 P.T.

British Research Association for the Woollen and Worsted Industries. Annual Report, 1925. Pp. 27+4 plates. (Headingley, Leeds.)

Clifton College Scientific Society. Report for the Years 1924-25. Pp. 24. (Bristol.)

Diary of Societies.

SATURDAY, MARCH 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Rare Gases of the Atmosphere and their Importance in Atomic Theory (4).

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—P. S. Lea: Notes on Safety Lamps.—Discussion of Papers by J. T. Pringle: Housing of Workmen; and F. J. Johnston: The Use of Breathing Apparatus in Mines.

TUBERCULOSIS SOCIETY (jointly with Society of Superintendents of Tuberculosis Institutions) (at Cambridge). (Continuation.)

MONDAY, MARCH 29.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (at Institution of Mechanical Engineers), at 2.30.—To inaugurate the Association.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. Canon A. Lukyn Williams: The Problem of the Septuagint and Quotations in the New Testament.

INSTITUTE OF ACTUARIES, at 5.—G. H. Recknell: The Bonus Earning Power of a New Business Fund.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Mr. Shattock: Demonstration of Specimens of Pathological Conditions of the Breast.

RAILWAY CLUB (at 65 Belgrave Road, S.W.), at 7.30.—W. J. Mitchellhill: Electricity in Railway Operations.

ROYAL SOCIETY OF ARTS, at 8.—W. F. Higgins: Thermometry (Cantor Lectures) (3).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Major T. G. Tulloch: Surface Combustion.

TUESDAY, MARCH 30.

ENGINEERS' CLUB (Manchester), at 1.45.—Annual General Meeting.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Sir Thomas Horder, Bart.: Endocarditis (Lumleian Lectures) (3).

INSTITUTE OF MARINE ENGINEERS, at 6.30.—E. Ford: Some Marine Researches and our Sea Fisheries.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (Annual General Meeting) (at Engineers' Club, Manchester), at 7.—R. B. Matthews: Electro-Farming; or the Application of Electricity to Agriculture.

ILLUMINATING ENGINEERING SOCIETY (at Lighting Service Bureau, 15 Savoy Street), at 7.—H. Lester Groom and others: Discussion on Stage Lighting.

ROYAL PHOTOGRAPHIC SOCIETY (Kinematograph Group), at 7.

RÖNTGEN SOCIETY (at Royal Society of Medicine), at 8.15.—Sir John Thomson-Walker: Radiology in Urinary Surgery (Silvanus Thompson Memorial Lecture).

ROYAL ANTHROPOLOGICAL INSTITUTE (Indian Section), at 8.15.—A. F. Geddes: Some Villages of Western Bengal.

WEDNESDAY, MARCH 31.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at 17 Fleet Street), at 5.30.—F. Nasmith: Fathers of the Machine Cotton Industry.—S. Daniloff: Some Unusual American Spinning Wheels.—R. H. Naumburg: Two American Textile Pioneers.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—E. V. Clark: Power Factor and Tariff.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Neville Hall, Newcastle-upon-Tyne), at 7.—A. Karl: The Analysis of Wave Making Resistance.

FRIDAY, APRIL 2.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at Glasgow), at 7.—Annual Meeting.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch, Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—L. Close: Boilers.

SATURDAY, APRIL 3.

SCOTTISH JUNIOR GAS ASSOCIATION (Annual Meeting) (at Royal Technical College, Glasgow), at 7.—Prof. T. Gray: Address.

PUBLIC LECTURE.

SATURDAY, MARCH 27.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. H. S. Harrison: Early Man and his Wanderings.

CONFERENCE.

TUESDAY, MARCH 30.

ROTHAMSTED EXPERIMENTAL STATION, HARPENDEN, at 11.30 A.M.—The Culture and Manuring of Fodder Crops.—Sir E. J. Russell: Rothamsted Experiments on Root Crops.—W. A. C. Carr: Swedes and Kale.—J. C. Brown: Mixtures for Forage Crops.—C. Heigham: Mangolds and Sugar Beet.

CONGRESS.

APRIL 2 TO 23.

JERUSALEM AND BEIRUT, INTERNATIONAL ARCHAEOLOGICAL CONGRESS.

SATURDAY, APRIL 3, 1926.

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Broadcasting in Great Britain.

THE Report of the Broadcasting Committee (H.M.S.O., Cmd. 2599, 6*d.* net), to which a brief reference was made in our issue of March 13, is commendably concise and at the same time practical; the recommendations made therein are likely to meet with general approval. The problem which the Committee had to consider, that of advising the Postmaster-General as to the scope of the broadcasting service in Great Britain and as to the management, control, and finance thereof after the expiry of the licence of the British Broadcasting Co. on December 31 next, is one which possesses several features containing special difficulties, not merely in relation to the scientific and technical aspects of the service, but yet more so in relation to various influences, still latent, which it may be capable of exerting on practically the whole range of human activities, political, commercial, educational, recreative, and social.

The Committee appreciates the great value of the work accomplished by the British Broadcasting Co., and properly places its admiration thereof on record; however, it recognises that the progress made in broadcasting since its inception in 1922 has already been so rapid and noteworthy that the organisation laid down for that Company no longer corresponds to national requirements or responsibility.

Having considered the various methods which seem available for the conduct of the service, the Committee, it is evident, felt that the prejudice on the part of a large section of the public against the continuance of a monopoly, sanctioned, supported, and protected by the State, is to-day so marked that, in spite of certain obvious advantages that the existing arrangement possesses, a great outcry would instantly have been raised against any proposal to allow broadcasting to remain in the hands of a body constituted on trade lines for the profit of those composing it. On the other hand, there was no getting away from the fact that, although the control by the State of a service with such far-reaching possibilities as those of broadcasting was absolutely essential, yet in view of the impression which widely prevails that the management of the wireless service already in the hands of the Post Office is inefficient, and the circumstance that it has proved unprofitable, it was certain very considerable opposition would be offered to any proposal which contemplated the transfer to a Government department of the undertaking of the British Broadcasting Co., with the exceptionally complicated features existing in its commercial as well as its scientific and technical side. In these circumstances, the Committee had to find a way out of the dilemma, and it has done so by definitely recommending that the broadcasting service should be conducted by a public corporation—the "British Broadcasting Commission" is suggested as a suitable title for it—acting as trustee for the national interest, and that its status and duties should correspond with those of a public service. It further proposes that the management of the corporation should be vested in paid Commissioners, who should be "persons of judgment and independence, free of commitments, with business acumen and experienced in affairs," in order that they may inspire confidence by having no other interests to promote than those of the public.

It is suggested that the Commissioners—to be not more than seven or less than five in number—should all be nominated by the Crown and hold office for five years, subject to an extension of this term on its expiry. The appointment of a considerable number of advisory committees is also contemplated; it is expected that on them, to a great extent, the duty will rest of ensuring due consideration for particular phases of broadcasting, in relation both to programmes and to scientific progress and research, although ultimately it is the Commissioners upon whom will devolve the task of laying down the general line of policy and initiating experiment and research. The appointment of these advisory committees will be in the hands of the Commissioners, who would, the Committee assumes, gladly consult societies and organisations which are qualified to advise on questions of personnel.

The finance of the Commission receives careful consideration; the view is definitely expressed that "the Commission must be self-supporting and can expect no grant from public funds." The Committee fully anticipates that (i) increasing outlay on plant will be necessary, (ii) the overhead and administrative charges of the new authority will rise, and (iii) the control of programmes will be more onerous than hitherto. It further lays down that outlay on bold experiment should not be meagre, and research, both official and unofficial, should be constant. The Committee is therefore of opinion that the expenditure of the Commission, which, it is recommended, should be empowered to raise capital on the security of its income from licence-fees, may be calculated on the assumption that the present licence-fee of 10*s*. per annum will be maintained in the future. The Postmaster-General, it is recommended, should remain the licensing authority, and continue to collect the licence-fees and be responsible for the detection and prosecution of those who conceal their equipment. He should be completely indemnified against all expenditure incurred by him in relation to the broadcasting service; subject thereto, the duty is imposed upon him of paying to the Commissioners from the licence-fees "an income thoroughly adequate to enable them to ensure the full and efficient maintenance and development of the service." Any surplus after the condition last mentioned shall have been met should, it is suggested, be retained by the State.

The Committee recommends that the Commission should be granted a licence by the Postmaster-General; in the first instance, this should be for a term of not less than ten years. The general framework of this licence should be similar to the existing one of the British Broadcasting Co., and would contain a variety of technical provisions, together with the general powers entrusted to the Commission and specific restrictions imposed in the interests of the State. This arrangement would admit of a complete review of the situation at a later date, and any changes, either in the method of control or in the organisation now proposed, which might be rendered necessary by the development of broadcasting, could then be readily introduced.

The Committee recognises that the British Broadcasting Co. has enjoyed certain advantages owing to the permission it had to use, without royalty, certain transmission patents, the property of the constituent members of the Company, advantages which may not appertain to its successor. However, it does not anticipate that any difficulty will arise in respect of these patents should their continued use be essential to broadcasting, and hints that if, at any time, the owners of patents attempt to impose unnecessarily burdensome conditions in relation to the use thereof by the Commission, Section 29 of the Patents and Designs Act, 1907, may not be without its relevance.

Among other matters not touched upon above, the report contains recommendations proposing that: (*a*) All existing contracts and the staff of the British Broadcasting Co. should be taken over by the new Commissioners; (*b*) the Commissioners should be entitled to all ordinary rights as regards copyright material, but it is considered unnecessary to invest them with any special privilege or preference in the matter; (*c*) the claims of listeners desiring a larger proportion of educational matter should, if possible, be met; (*d*) a moderate amount of controversial matter should be broadcast, provided the material is of high quality and distributed with scrupulous fairness; and (*e*) the prestige and status of the Commissioners should be fully acknowledged and their sense of responsibility emphasised.

A historical summary of the broadcasting service in Great Britain is contained in an appendix to the report, the concluding paragraph of which appropriately shows the growth, quarter by quarter, in the number of wireless receiving licences: at March 31, 1922, the number of licences current was 7690, and had by January 31, 1926, increased to 1,840,268.

Work and Needs of the Smithsonian Institution.

THE Smithsonian Institution is appealing to the American public for an addition of ten million dollars towards its endowment. The grounds of this appeal were put in a very forcible and interesting way by Mr. Austin Hobart Clark, in an address to the American Association for the Advancement of Science, at Kansas City, on January 1. Readers of NATURE know something of the Smithsonian and what it has done. Its general policy has been to encourage research along all lines that do not receive adequate support from other sources, but never to interfere with work done under other auspices. In this way it has led to the establishment of ten technical bureaux, which now proceed as Government establishments, though in close touch with, and sometimes under the supervision of, the Smithsonian. The fields in which the Institution is desirous of expanding are mainly those of astrophysics, oceanography, entomology, palæontology, anthropology and archæology, animal diseases, botany, zoology, intensive exploration, and publications. While far from unmindful of the economic importance of these varied activities, the Smithsonian recognises that the vast extension of applied science and its superior rewards are attracting the best of the younger generation, so that the stream of those to whom we should otherwise look for the elaboration of new ideas and theories is being deflected elsewhere. It will therefore be the aim of the Smithsonian in the future, even more than in the past, to promote research in pure science.

The most detailed part of Mr. Clark's interesting address on the work of the Smithsonian Institution was, as might be expected from his own studies, that dealing with the investigation of the sea. He showed in how many points our knowledge is either lacking or too vague for present-day requirements. In the course of his illustrations of economic entomology, he urged the necessity for exact specific identification by comparison with the types in museums, and incidentally mentioned that new kinds are being described at the rate of about six thousand a year, at which rate he estimates that it will take five hundred years to complete the task. Under "Animal Diseases" he announced that it is proposed to establish a laboratory for their study in the National Zoological Park. The botanical programme includes exploration and study of the plants in Colombia, Ecuador, and Venezuela, where the flora is less known than in any other section of the western hemisphere. The need for bringing all this knowledge, not merely to professional workers, but also to the general public, was strongly emphasised.

Mr. Clark claims that the leadership in science which he is pleased to assign to England is intimately connected with the widespread interest as manifested in the large number of amateur scientific societies. Newspapers and magazines show that the interest exists; on men of science falls the responsibility of providing accurate material and plenty of it. Where stimulus is needed is in the presentation of the results of pure science, and here it is sad to note that increased costs have forced the Smithsonian to suspend its "Contributions to Knowledge" and to reduce the "Miscellaneous Collections" by two-thirds. The Smithsonian Institution is appealing for increased endowment. Founded by an Englishman nearly a century ago, it has greatly assisted the workers of Great Britain as well as those of other countries. Would it not be fitting and gracious that Great Britain too, though from a straitened purse, should make some response to this appeal?

Science and Religion.

Science, Religion and Reality. By the Earl of Balfour, Dr. Bronislaw Malinowski, Dr. Charles Singer, Dr. Antonio Aliotta, Prof. Arthur S. Eddington, Joseph Needham, Rev. Dr. John W. Oman, Dr. William Brown, Prof. Clement C. J. Webb, Rev. Dean Inge. Edited by Joseph Needham. Pp. v+396. (London: The Sheldon Press; New York and Toronto: The Macmillan Co., 1925.) 12*s.* 6*d.* net.

THERE has been of late a recrudescence of interest in the relations between science and religion, and the present book is a solid and important contribution to the study of this question, so fundamental for every thinking man. The book is remarkable also as showing how great a change has taken place in the attitude both of the theologian and of the scientific man towards this ever-present problem. The hearty days are gone when Huxley gave battle to the bishops, and fierce controversy raged through the pages of the serious reviews. In this book the spirit of antagonism is gone, and there is an earnest seeking after not compromise, but reconciliation. The pages breathe a sweet reasonableness, and one almost longs—in unregenerate moments—for a little clashing of swords.

In all seriousness, however, this change of attitude is to be welcomed, for every man must make his peace both with science and with religion if his life is to be complete and harmonious. The change is no one-sided one; the theologian realises more and more that he must frankly accept all the well-established facts of science and jettison ruthlessly outmoded cosmologies and fables of creation; the man of science on his part is beginning to recognise that the principles he finds serviceable in the investigation of the material world cannot safely be erected into a comprehensive philosophy of existence. So both sides abate somewhat of their pretensions, and a working reconciliation becomes possible.

It is very difficult to summarise a book of this kind—the work of many hands, approaching the problem from many different viewpoints—the more so because it is not a symposium, but a collection of papers written independently of one another. There is a short introduction by the Earl of Balfour, and a long concluding article by Dean Inge, which in some measure sums up and appraises the work of the contributors, while remaining a brilliant and individual presentation of the Dean's own views, written from an avowedly Christian point of view with all that skill, competence, and originality which we have learnt to expect from him.

About half the book is historical in treatment, the rest a presentation in different ways of both the religious and the scientific points of view.

Dr. Malinowski, in a well-thought-out and interesting article on "Magic, Science and Religion," based largely upon his own personal researches in Melanesia, succeeds in distinguishing clearly between the spheres in savage life of practical—not theoretical—science, magic, and religion. In his dealings with the world around him, in his activities as hunter or tiller of the ground, the savage is necessarily a practical man of science, depending upon the uniformity of Nature for the return of seed time and harvest time and for success in the chase. Magic is defined as "a practical art consisting of acts which are . . . means to an end expected to follow later on." It is akin to science in that "it always has a definite aim intimately associated with human instincts, needs, and pursuits." It is often an attempt to influence favourably a chancy or inimical environment. Religion has a different function and is pre-eminently social.

> "Religious faith establishes, fixes, and enhances all valuable mental attitudes, such as reverence for tradition, harmony with environment, courage and confidence in the struggle with difficulties and at the prospect of death. This belief, embodied and maintained by cult and ceremonial, has an immense biological value, and so reveals to primitive man truth in the wider, pragmatic sense of the word" (p. 82).

There is naturally at this stage of development no struggle between science and religion, for science is quite undeveloped.

In the next essay, Dr. Singer gives us a scholarly account of the "Historical Relations of Religion and Science," treating antiquity and the Middle Ages in some detail and in a most interesting way, and concluding with the final establishment by Newton of the modern cosmology. This historical survey raises many difficult and important problems into which it is impossible to enter fully here. Why, for example, did science suffer a long eclipse from about A.D. 200 to 1500? Was it the influence of the Church, the authority of Aristotle, or were the causes many and complex? From the Stoics onwards, many forms of religion were definitely hostile to science, and the spirit of free inquiry was—from whatever causes—effectively stifled. Active conflict with religion scarcely arises before the birth of modern science, which Dr. Singer dates about 1600.

Early in the seventeenth century, the work of Galileo and Kepler, following on that of Copernicus, began to bear fruit, and presented men with a picture of the universe differing irreconcilably from the geocentric cosmology of the Scriptures and of Aristotle. Here was a clear-cut issue on which no compromise was possible, and in which right was entirely on the side of science. Astronomy inflicted a serious blow upon the Christian conception of the universe, far more serious than that later delivered by the theory of evolution, for evolution can be regarded by the theologian as merely the means of creation, and the conception of gradual development is not incompatible with the Christian theology. Dean Inge goes so far as to say that to this day the Churches have not really faced the problem of reconciling Scriptural doctrine with the incontrovertible teachings of astronomy:

> "The task has been put off from generation to generation, and to this day little has been done to relieve the strain upon the intellect and conscience of the Christian world. Those Churchmen who airily declare that there is no longer any conflict between Christianity and science are either very thoughtless or are wilfully shutting their eyes. There is a very serious conflict, and the challenge was presented not in the age of Darwin, but in the age of Copernicus and Galileo" (p. 357).

Dean Inge advises the Churches to adopt the honest and sensible policy of recognising that "all theological doctrines which rest upon the geocentric theory must be recast, inasmuch as the results of science are, within their own sphere, unassailable" (p. 360).

The paper by Prof. Antonio Aliotta, which follows, is entitled "Science and Religion in the Nineteenth Century," and brings the story up to modern times. Here we are introduced to questions of philosophy, and the recent revolt against Intellectualism is treated ably and sympathetically. Perhaps we can best sum up Prof. Aliotta's point of view by the following quotation:

> "Science and philosophy strive to order the world of our symbols and concepts into the unity of an idea. But the idea does not exhaust the reality; the articulation of concepts will never bring about the attainment of the fullness of life, in which, therefore, our spirit does not find itself understood. Harmony of thought is not sufficient; we wish to feel ourselves to be truly living souls. We do not wish merely to conceive, we wish

also to realise in sentiment and action the concrete unity of life. That is exactly the meaning of religion. The love of our neighbour and the love of God are at the bottom the same aspiration towards this harmony of the lived experiences " (p. 182).

Philosophical questions are brought into prominence also in the next two papers, " The Domain of Physical Science," by Prof. Eddington, " Mechanistic Biology and the Religious Consciousness," by Mr. Needham, and with the latter may be linked up the acute criticism of Naturalism to be found in the concluding paper.

Prof. Eddington discusses in a lively and vivid way the scope and significance of theoretical physics, especially as affected by the doctrine of relativity, and comes to the conclusion

> " that the external world of physics is in the first place approached by way of consciousness, that it derives actuality and value from consciousness, and that it relates only to certain aspects of the common basis of material and spiritual things. The dance of electrons in the brain is only a partial aspect of the mental states and resolutions occurring, and there is no reason why it should claim to reveal the whole inner constitution by which one mental state leads to another " (p. 214).

We do not know quite what to make of the position taken up by Mr. Needham with respect to biological method. In the first part of his article his enthusiasm for biochemistry rather carries him away. He contends that in these days zoology must give place to, or rather has already become, comparative biochemistry and physiology biophysics.

> " The causes for the change lie deep, but the effect has been a profound infiltration of physico-chemical ideas and terminology into the whole biological field, and this implies a corresponding peaceful penetration of the mechanistic theory of life. This change from comparative morphology to comparative biochemistry is indeed one of the most important factors in the scientific history of the last few decades. It will never again be equalled in importance until comparative biochemistry passes over into electronic biophysics " (p. 224).

Mr. Needham assures us that the mechanistic method has triumphed finally over vitalism and neo-vitalism, confounding under this term such diverse views as those of Driesch and Haldane. His attack on vitalism has much weight when directed against theories that rely on ' vital forces ' or entelechies, and it must be conceded also that no vitalistic theory as yet has been developed into a coherent body of biological doctrine anything like so imposing as the mechanistic scheme; but has the problem not moved a little further nowadays than the mere opposition of materialism to vitalism? No one denies the great value of biochemical research, or the validity of its findings of fact, but some of us feel constrained to question whether physics and chemistry alone are sufficient to give us a real biology. Can biology get on satisfactorily as a mere annexe of the physical sciences, or does it not require concepts and methods of interpretation which shall be peculiarly its own? Biology in this sense could coexist comfortably with biochemistry—the two points of view would be complementary, not antagonistic.

Later on in his paper Mr. Needham seems almost to admit this. He recognises that " although mechanism in biology is perfectly justified and indeed essential, it cannot be applied to psychology," and he outlines a form of animism according to which

> " it is the physical functions of life that physics and chemistry are competent to explain, for such questions as the distribution of animals and the general theory of evolution, which obviously involve the consideration of conscious striving, do not come under their entire dominion. MacBride in a recent essay has spoken of evolution as a vital phenomenon, but, from his actual words, this means no more than that evolution is in part a mental or psychological phenomenon, and in this respect we may fully agree with him " (p. 254)

Just how far down in the scale Mr. Needham is prepared to admit the existence and efficacy of ' mind ' is not very clear, nor whether with McDougall he regards blind purposive striving as an indication of ' mind ' or restricts the term to the conscious manifestations of purpose.

One has the impression that Mr. Needham, having broken with Descartes, has gone some little way towards modifying his fervent belief in mechanism, and may yet go further.

There should be read in connexion with Mr. Needham's paper the able presentation in Dean Inge's article of the anti-mechanistic point of view. He is of opinion that the attempt to explain life and evolution on mechanistic principles has failed and that nothing remains but to explain Nature spiritually. He sees signs of this change of attitude in the interest which is being shown in panpsychism, and directs attention to the remarkable philosophy of Fechner, which is known to English readers mainly through a sketch of it contained in William James's book, " A Pluralistic Universe."

Of the three remaining articles in the volume, two, by Dr. Oman and Prof. Webb, deal respectively with " The Sphere of Religion " and " Science, Christianity and Modern Civilisation " from the point of view of the Christian theology; the other, by Dr. W. Brown, treats in an extraordinarily sympathetic spirit the psychology of religious experience. He finds that there is a distinctively religious experience, a distinctive attitude to, or feeling of dependence upon, the Universe, which can be but partially analysed by psychology, and the content of which cannot be completely exhausted by such analysis.

To sum up our impressions of this notable book—it seems to us clear that science and religion have each their own sphere and function in human life. Science is primarily an intellectual reconstruction of experience; religion is a man's whole relation, mental, moral, and spiritual, to the totality of existence. Religion is not primarily an intellectual effort, an imperfect philosophy, but an attitude of the spirit as a whole. If, on one hand, the man of science recognises the philosophical limitations of his methods, and on the other hand, the man of religion honestly faces and accepts the proved results of scientific research, there seems no reason why they should be in conflict. Danger comes on either side from dogmatism and respect for authority.

E. S. R.

The Phylogeny of Flowering Plants.

The Families of Flowering Plants. I. Dicotyledons. Arranged according to a new System based on their Probable Phylogeny. By J. Hutchinson. Pp. xiv + 328. (London: Macmillan and Co., Ltd., 1926.) 20*s*. net.

IT is an interesting coincidence that two books dealing systematically with the Dicotyledons should appear about the same time. The much-delayed second volume of Dr. Rendle's "The Classification of Flowering Plants" was issued at the close of 1925, and Mr. Hutchinson's work, herein reviewed, at the opening of the present year. The manner of their appearance suggests a prediction to the effect that one marks the close of a chapter and the other the opening of a new one in British systematic botany. The classification of Engler upon which Rendle's useful and informative text-book is based has, we venture to say, run its course, and botanists generally, at any rate the younger school, will welcome this refreshing and originally conceived handbook of Mr. Hutchinson's, with its new classification professedly framed on phylogenetic lines and actually at any rate on sound and stimulating ones.

At present Mr. Hutchinson is publishing in the *Kew Bulletin* a series of papers on the phylogenetic classification of flowering plants, the end in view being, we believe, the production of a *magnum opus* in the shape of a new "genera Plantarum." The present volume is a foretaste—a *parvum opus*—dealing only with the families. It is a means of addressing a larger botanical public than he could hope to reach through the pages of the *Kew Bulletin*.

Since an article appeared in NATURE only a year ago (vol. 115, pp. 340 and 385) on this subject, readers especially interested are referred to this, as space will not permit of the same ground being re-traversed. Hutchinson's principles of classification and his new arrangement of the Archichlamydeæ (Polypetalæ and Apetalæ combined) were there explained and comments made. In this book for the first time his scheme for the Metachlamydeæ (Sympetalæ)—the higher Dicotyledons with corolla in one piece—is outlined, and in his ingenious phylogenetic diagram facing p. 8, he shows how he proposes to derive them from the lower free-petalled orders. He is here still fertile in new ideas, continuing to employ what might be called his *leitmotiv*, namely, the derivation of the Dicotyledons in two branches, one from the Magnoliales with the tree-habit dominant and the other from the Ranales with the herbaceous habit prevailing. The former is considered to have given rise to the Ebenales (possibly straight from the Anonaceæ), the Ericales, Apocynales, and Rubiales; the latter to the primroses, gentians, scrophs, labiates, etc. The Compositæ are regarded as of mixed origin and are no longer given pride of place among dicotyledonous plants. This is now awarded to the Labiatæ.

The book begins with a short, well-balanced foreword by the Director of the Royal Botanic Gardens, Kew. The author's preface follows. Here stress is laid on the distinction to be drawn between a phylogenetic classification and a key. One should emphasise rather the *resemblances* and the other the *differences* between plants. One aims at a truly natural system by striving to discover relationships. The other is purely artificial and constructed solely for the easy identification of plants. Taxonomists in the past, by trying to compromise, have failed on one hand to stimulate inquiry, and on the other to give the most readily worked keys. Hutchinson sets out to keep these two ends in view quite distinct.

The introduction is largely a reprint of his general remarks on classification which appeared in the *Kew Bulletin* about three years ago. A useful table is added contrasting his new system with those of Bentham & Hooker and Engler & Prantl. Then follows the phylogenetic system itself. After this comes the artificial key to the families of the Dicotyledons, 264 in all. This is an ambitious effort, and if workable, as apparently it is, should prove of considerable practical value, especially to botanists and foresters stationed in the tropics.

The descriptions of the families which naturally occupy the greater part of the book are concise and clear. The numerous illustrations, one, in fact, to each family, form a noteworthy and attractive feature. These are from the pen of Mr. Trevithick and the author. Some are original and few are hackneyed. In each figure a flowering shoot of the plant selected to illustrate the family is shown along with enlarged details. No scale, however, is given. One cannot refrain at this point from mentioning the frontispiece. This is from the author's own designing and charmingly represents in floral form the ideas of affinity expressed in this work. It surrounds the appropriate dedication, namely, to the memory of George Bentham and Joseph Dalton Hooker. A strong point is made of geographical distribution, and several maps are given showing family or generic distributions of a restricted or otherwise interesting character. An appeal is made to the economic botanist and horticulturist by enumerating, at the end of each family, plants useful to man. Some reference to the mode of pollination might have increased the value of these descriptions. The book ends with a glossary and index.

Manuals of this kind published in England usually lay stress on the families which are especially exemplified in the British flora. This, though quite understandable, is apt to give the student a restricted and wrongly balanced conception of the flowering plants of the world as a whole. Hutchinson avoids this by treating all families alike. Hence the book is suitable for any part of the world. A companion volume dealing with the Monocotyledons is promised. Eventually we hope that both Dicotyledons and Monocotyledons may be included within the pages of a single book and issued at a cost not exceeding that of the present volume.

This work might have benefited from more detailed inspection when in proof. The mistakes and omissions are chiefly noticeable in the explanations to the illustrations. These are, however, not likely to be misleading.

In conclusion, we should like to congratulate the author in particular and Kew in general on this forward move in taxonomy and the study of the flower. The views expressed as to the inter-relationships of the Dicotyledons should arouse research in this department of botany. Several lines of inquiry will, one imagines, suggest themselves to interested and critical readers.

J. PARKIN.

Principles and Practice of Electrochemistry.

(1) *Principles and Applications of Electrochemistry.* In 2 vols. Vol. 1: Principles. By Prof. H. Jermain Creighton. Pp. ix+446. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 20*s.* net.

(2) *Theoretical and Applied Electrochemistry.* By Prof. Maurice de Kay Thompson. Revised edition. Pp. xix+551. (New York: The Macmillan Co., 1925.) 20*s.* net.

(1) PROF. CREIGHTON'S book on electrochemistry deals exclusively with "Principles," but is to be followed by a second volume on "Applications of Electrochemistry" by Prof. Colin G. Fink. The theoretical volume is a well-balanced treatise, which covers in a satisfactory manner the principal methods of measuring conductivities, ionic mobilities, and electromotive forces, as well as the deductions that can be drawn from these measurements. It is, however, not a very easy matter to write a text-book on theoretical electrochemistry at a time when physicists have declared that, even in the solid state, there is no such thing as a molecule of common salt, but only an aggregate of ions, and when physical chemists are beginning to explore the possibility of applying the same drastic conclusion to salt solutions. What, for example, is to be done in these circumstances with the old hypothesis of Arrhenius, which has formed the basis of all such treatises during the past thirty years, but must now apparently be regarded as obsolete?

As a provisional solution of the problem, the author has adopted the worldly-wise policy of writing his book in terms of the old hypothesis, instead of rewriting it in terms of modern physical conceptions; and he justifies his retention of this hypothesis by quoting with approval a statement of Kendall that "no case has yet been made out for its abandonment." Nevertheless, it is clear from the reservations that he makes, and from the explanations that he gives, that the foundations have already crumbled and must speedily be replaced, even if this involves only an underpinning and not a rebuilding of the old superstructure.

One fascinating application of the newer point of view is made in connexion with amphoteric electrolytes. According to the traditional method of formulation, the un-ionised portion of an amino-acid was regarded as made up of electrically neutral molecules of the type $NH_2 . CHX . COOH$. In the newer system it is natural to regard it as having a similar structure to ammonium chloride, $\overset{+}{N}H_4\overset{-}{Cl}$, and therefore to write it in the form of a bipolar molecule or ***zwitterion***, $\overset{+}{N}H_3 . CHX . CO . \overset{-}{O}$. The effects of this simple change have been worked out by Bjerrum, who has thus deduced an entirely new set of dissociation constants for these compounds. In particular, he finds that the acid dissociation constants of the amino-acids are larger than those of the carboxylic acids from which they are derived, instead of being very much smaller; and their basic dissociation constants are also found to be much larger than was formerly supposed. Thus, in the case of asparagine, the acid dissociation constant is of the order of 10^{-2} instead of 10^{-9}, and the basic dissociation constant is of the order of 10^{-5} instead of 10^{-12}. The theoretical deductions from these altered numbers need not be discussed; but it is at least clear that grave risks are involved in drawing deductions from data that have not been examined in the light of the modern physical theory of atomic structure.

In accordance with a practice which is becoming increasingly common, a series of problems has been added to each of the principal chapters. Experience shows that problems such as these are of great value in fixing the subject matter of the text in the mind of the reader, if he is willing to make use of them, and their inclusion in the present volume is therefore to be welcomed.

(2) Prof. Thompson's "Theoretical and Applied Electrochemistry," based originally upon a course of lectures on applied electrochemistry at the Massachusetts Institute of Technology, appeared first in 1911. The principal change in the second edition arises from a decision to include in the volume a treatise on theoretical electrochemistry as well, in response to suggestions made by readers of the first edition. The sections on "Applied Electrochemistry of Aqueous Solutions" and on "Electric Furnaces and their Products" have, however, also been revised and largely rewritten. The author has received assistance from a large number of those engaged in the electrochemical industry of the United States, and there can be little doubt that his book gives a satisfactory account of the present position of the industry so far as this is available for publication.

The Spirit of Modern China.

From Peking to Lhasā: the Narrative of Journeys in the Chinese Empire made by the late Brig.-General George Pereira. Compiled by Sir Francis Younghusband from Notes and Diaries supplied by Major-General Sir Cecil Pereira. Pp. x+293+33 plates. (London: Constable and Co., Ltd., 1925.) 18*s*. net.

GENERAL PEREIRA'S notes, from which this volume has been compiled by Sir Francis Younghusband, cover three journeys. Of these, the first from Peking to Lhasa and India is the longest and the one of which the account is the most detailed. It is also the most interesting, for the author was the first European to succeed in reaching Lhasa from China since 1848, when Pères Huc and Gabet reached the Holy City from this direction. This journey was in itself a remarkable feat for a man nearly sixty years of age and physically weak; but almost immediately he started on his second journey from Burma to Shanghai, and then, in attempting to traverse China from south to north, he died in 1923 while on his way from Yunnan to Kansu.

Pereira was particularly well qualified for the task he had set himself. He had resided long in China and had visited every one of its provinces, either as a private individual or as an official. His notes of his journey are therefore valuable not merely as a geographical record; they also embody the acute observations on conditions in China in the years 1921–23 of one who was intimately acquainted with the people. In addition, three chapters written by Pereira himself, one in 1921 and two in 1923, summarise his views of the situation. He held that the evils of the imperial system had been multiplied under the Republican Government, while the checks on undue extortion and the influence of the students had been removed. The great dangers, as he saw them, were the facility with which popular opinion might be diverted into dangerous channels, as had happened in the Boxer movement; the student movement with its superficial acquirement of Western ideas; and generally, the lack of discipline in education, due to the weakness in the position of the foreign teacher, and the increase in the numbers of the soldiery, who at the least inducement were liable to become brigands. These factors were, of course, additional to and dependent on the lack of a strong central government. The proposal to abolish extraterritoriality he considered to be due to a misunderstanding of the position outside of the treaty ports, where Europeans lived in conditions which were practically Western.

Subsequent events have largely justified Pereira's views, even if to some little extent these are coloured by his training and mentality. The emphasis he lays on the importance of the student class as the future governors of the country, and his acute analysis of its weaknesses, lend support to the views of those who press the need for the inculcation of a new public spirit in Chinese affairs, and hope that it may be attained through co-operation between Britain and China in extending the facilities for university and secondary school education by means of the Boxer indemnity.

The Kiwai.

Among Papuan Headhunters: an Account of the Manners and Customs of the Old Fly River Headhunters; with a Description of the Secrets of the Initiation Ceremonies divulged by Those who have passed through All the Different Orders of the Craft, by one who has spent many Years in their Midst. By E. Baxter Riley. Pp. 316+16 plates. (London: Seeley, Service and Co., Ltd., 1925.) 21*s*. net.

IN this book we have the observations upon the natives of the region of the Fly estuary by a missionary who has been in the district for twenty-five years, and as he has taken a lively and sympathetic interest in the people under his care, we may accept his account with confidence. Mr. Baxter Riley nowhere refers to missionary work as such; his aim evidently has been to give his readers a knowledge of native life and customs without obtruding the personal element.

The old order is rapidly changing, but the former conditions are not so far distant that they have become seriously obliterated. The author admits that he has omitted certain details which might be considered to be out-of-place in a book designed for the general public, and it is obvious that in a book of this kind a selection must be made. Nevertheless, ethnologists will find a great deal of information which has not previously been published. As a matter of fact, a good deal has been written in English in scattered publications about these people, but mainly from an external point of view, though Dr. G. Landtman has published intensive papers on such subjects as: Wanderings of the dead in the folk-lore of the Kiwai-speaking Papuans (*Festskrift*, E. Westermarck, 1912), the poetry of the Kiwai Papuans (*Folk-Lore*, 1913), Papuan magic in the building of houses (*Acta Acad. Aboensis Humaniora*, 1920), and especially his great work "The Folk-tales of the Kiwai Papuans" (*Acta Soc. Sci. Fennicae*, 47, 1917); but most of these are not readily accessible to the non-specialist reader. This book, therefore, fills a gap in our knowledge of the region, and the accounts of the various ceremonies are of considerable value.

A more detailed account of their ethical ideas, however, would have been welcome, for, after all, the ideas and ideals of a people are the most important phenomena, and it is these which are usually so lacking in ethnographical descriptions; but perhaps a missionary is not always in the best position to obtain these, as they are, as a rule, what he has come to replace, and the natives know this. The three-line paragraph on "The State after Death" is clearly inadequate; fortunately Dr. Landtman has given us full information on this matter. The book concludes with an interesting chapter on the "Psychology of Native Dancing." The book is well illustrated by photographs and native drawings, and there are two maps.

A. C. HADDON.

The Preservation of Food.

Department of Scientific and Industrial Research. Report of the Food Investigation Board for the Year 1924. Pp. vi+80+6 plates. (London: H.M. Stationery Office, 1925.) 3*s*. 6*d*. net.

THE work of the Food Investigation Board ranges from laboratory experiments on the chemistry of foods or allied materials and on the physics of methods of preservation, to large scale investigations on the storage of various foods under commercial conditions, and on the engineering problems connected with this subject. The first section is devoted to the theory of freezing: it has been found that discs of gelatin frozen slowly show an outer shell of ice and an inner core of concentrated protein, while with very rapid freezing there is no external shell of ice, but the ice phase is distributed throughout the gel in the form of small discrete spheres of about 3μ in diameter. Intermediate rates of freezing give intermediate results. The displacement of water involves not only a permanent alteration of microscopic structure but also a permanent molecular change; but the actual separation of water on thawing, as in the 'dripping' of frozen beef when thawed, seems to occur only with a slow rate of cooling when ice separates on the surface of the colloidal material.

Further investigations have been carried out on the freezing of eggs and on the chemistry of muscle. The curious change in the yolk on freezing below $-6°$ C. for a sufficient length of time, whereby it passes into a stiff pasty condition on thawing, appears to be due to an irreversible precipitation of the lecitho-vitellin. It was found also that eggs retain their fertility longest at 8°-10° C., and die at $-7°$ C. Further work has been carried out on the production of lactic and succinic acids in muscle, and a new investigation commenced on the oxidation-reduction potential of the cell interior.

About half the report is taken up with the section on the preservation of fruit and vegetables, most of the work having been carried out on apples. The chemical changes occurring on storage and the conditions favouring or hindering the growth of fungi and the deterioration of the fruit on keeping have been investigated in great detail. The respiratory activity falls off *pari passu* with the acid concentration during the growth of the apple, whether on or off the tree, until senescence sets in, when an abrupt rise occurs. Alterations of respiratory metabolism occurring with 'internal breakdown' lead to the production of acetaldehyde and alcohol; this change is accelerated by a certain amount of carbon dioxide in the external atmosphere and is retarded by a smaller concentration in the presence of oxygen; an atmosphere of pure carbon dioxide is almost as favourable as air with a carbon dioxide content below the critical value. The optimum conditions of storage are difficult of attainment, since the following factors all affect the results: species of apple, nature of soil on which it is grown, season, temperature and atmosphere of storage chamber. Other work has been carried out on the chemistry of oils and fats, and of carbohydrates, including the chemistry of glycogen. The final section is devoted to some engineering problems in refrigeration, and closes an extremely interesting report.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Rock-lead, Ore-lead, and the Age of the Earth.

IN 1921 Prof. H. N. Russell attempted to fix an upper limit to the age of the earth on the basis of an assumption that all the lead in igneous rocks was of radioactive origin (*Proc. Roy. Soc.*, A, vol. 99, p. 84). He took the proportion of lead as 22×10^{-6} (gr. per gm.) and obtained in consequence a very high maximum age. This proportion appears to be based largely on analyses of rocks from the neighbourhood of galena veins, and is therefore probably not a fair average for igneous rocks as a whole. An estimate more applicable to the problem is provided by an analysis for lead of 329 igneous rocks, made in 1914 by F. W. Clarke and G. Steiger (*Journ. Wash. Acad. Sci.*, vol. 4, p. 58). They found a proportion of only $7{\cdot}5 \times 10^{-6}$. The present proportions of uranium and thorium in average igneous rocks are respectively 6×10^{-6} and 15×10^{-6}, the lead-generating equivalent in terms of uranium alone ($U + 0{\cdot}37$ Th) being $11{\cdot}5 \times 10^{-6}$.

If all rock-lead has been derived from the radioactive elements, then the equivalent amount of uranium must have been $8{\cdot}6 \times 10^{-6}$, giving an original total of equivalent uranium of $20{\cdot}1 \times 10^{-6}$. The time required for this original amount to disintegrate into $7{\cdot}5 \times 10^{-6}$ parts of lead and the corresponding quantity of helium, leaving the existing amounts of uranium and thorium, is approximately 3200 million years.

On the above figures, or on the data for any individual type of rock, granitic, basaltic, or peridotitic, the atomic weight of rock-lead should be a little less than 207. The lead of commerce, which is ore-lead derived almost entirely from the common vein mineral galena, is 207·2; and no significant deviation from this standard figure has been detected. Whatever the age or locality of galena may be, the atomic weight of its lead appears to be in all cases substantially higher than 207. It is therefore certain that ordinary lead cannot have been wholly derived from the radioactive elements during their terrestrial history, and this conclusion leads to two remarkable deductions.

Since an unknown amount of the lead in igneous rocks may be ordinary lead, it is clear that the earth—as a radioactive container—cannot have existed for so long as 3200 million years. This is in accordance with the evidence of radioactive minerals. Uraninites and other minerals from the Middle Pre-Cambrian rocks of Norway, Sweden, Ontario, Texas, Colorado, India, and Mozambique all give ages between 1000 and 1100 million years. The greatest age yet determined is that of a pitchblende from the Black Hills of South Dakota. I am indebted to Prof. A. C. Lane for an analysis of this mineral recently made by Mr. C. U. Davis, of the United States Bureau of Mines. It indicates an age of 1525 million years, and the atomic weight of the lead separated from it has been determined by Mr. L. P. Hall as 206·07. The frequently-quoted figure for the age of the earth, 1600 million years, thus appears to be of the right order, provided that the method, as I believe it to be, is sound in principle.

Accepting this provisional estimate, it follows that roughly half the lead of igneous rocks is of radioactive origin. It also follows that the ore-lead of mineral veins cannot be a concentration of the lead of igneous rocks, as is usually supposed. At least the greater part of the lead of ore-deposits must have been already in existence when uranium and thorium began to generate lead in the crustal rocks. Consequently, unless one assumes that ordinary lead can have been formed within the earth by some other unknown process, it seems safe to conclude that ore-lead must have originated either in the ancestral sun or during the events that attended the birth of the solar system. In the former case it may have been of radioactive origin, but if so it must have been generated during a period over which the average ratio of uranium to thorium was 6 . 16·2, in order that the resulting mixture of isotopes should have an atomic weight of 207·2. The terrestrial ratio is not less than 6 : 15, and if this is a guide to the solar ratio, the latter must in former ages have been greater than 6 : 15 instead of less, because the half-period of uranium is much shorter than that of thorium. On the other hand, if ore-lead is not of radioactive origin, as the argument suggests, then uranium and thorium must either have originated or have become radioactive at about the time of the birth of the solar system.

From the point of view of ore-genesis, the distinction drawn between ore-lead and rock-lead is of fundamental importance. It implies that the ore-bodies in which galena occurs are not derivatives from the igneous rocks visibly associated with them in time and place. J. E. Spurr has already concluded from the distribution of ores that the "magmas" of the latter are not residual fluids expelled from igneous rocks during their crystallisation, but that they are magmas of a special type developed in a zone that is locally a rich storehouse of certain metals.

It is clear that if the atomic weight of rock-lead could be determined, the result, whatever it may be, would throw a searching light on many baffling problems. To separate sufficient lead for the purpose from a representative collection of the world's igneous rocks would be a herculean task, but the value of the result would justify the labour, and I have penned this letter partly in the hope that some great research association, such as those of the United States, may be persuaded to undertake it.

ARTHUR HOLMES.

The University, Durham,
March 10.

Miller's Ether Drift Experiment and Stellar Motions.

IN connexion with Dr. Miller's recent announcement (*Science*, 63, 105, 1926) of his results in measuring the 'ether drift,' the writer wishes to direct attention to a few points which may be worthy of interest.

If we suppose that Miller's results are real, and if we try to interpret them as a partial drag of the ether, it is difficult to avoid conflict with known facts about first order (v/c) effects. The constant of aberration and the Michelson-Gale experiment for determining the earth's rotation by optical means give, within the errors of measurement, the full effect expected from theory, whereas Miller's experiment seems to give a greatly reduced effect of an ether drift. But if we interpret his results in terms of what they really are, second order effects (v^2c^2), most of the difficulties disappear.

The displacements measured by Miller correspond to a change in the length of his interferometer of the order 10^{-9}, and his final errors are about 5 per cent. of this quantity. There are probably several explanations for this change in length of his interferometer or in the velocity of light, but if a contraction in the Lorentz-Fitzgerald sense (that is, one due to 'absolute' motion in a stationary medium) exists, it is *only* by experiments of this type that we have as yet been able to determine whether the supposed change in the velocity of light in different directions is *exactly* compensated by the contraction within quantities of this order of magnitude. If this compensation is not exact, the expression for the Lorentz-Fitzgerald contraction, and the fundamental formulæ in the special theory of relativity, require a small but important modification of such a form that the 'absolute' motion enters explicitly into the final expressions. A corresponding modification must also be introduced into the space-time transformations of the general theory, but as these modifications are of the order of only 5 per cent., or more probably 3 per cent., no conflict need arise with the observed facts as regards the tests of the general theory of relativity. But in this case we are obliged to admit the existence of a fundamental reference frame which plays an active rôle in determining physical phenomena.

If the 'absolute' motion does not completely vanish in the case of contraction of matter, it is likely that the expression for the change of mass of an electron requires a corresponding modification, so that the absolute motion enters explicitly. Our ordinary conception of electro-magnetic mass is connected with the way in which the 'field' reacts on the motion of a charged body, and if the mass of an electron is a function of its absolute motion, we may expect a resultant momentum opposing the absolute motion of an atom, but noticeable only when the electron connected with the atom has a velocity approaching the velocity of light. Inside the atoms of the heavier elements, and even more in radioactive processes, electronic velocities occur which approach the velocity of light. As this reaction presumably is exceedingly small, it is difficult to detect. The most promising objects to study are the stars, for which the impulses have opportunity to accumulate for a very long time without being modified by collisions. For a system of stars like our local star system, for which we can assume a community of origin, that is, small initial relative velocities, we may thus expect an asymmetry in the distribution of stellar motions. The motions of the stars in our local system actually show such an asymmetrical distribution and of just such a type as is to be expected from a velocity restriction in a fundamental reference frame in which the globular star clusters and the spiral nebulæ are statistically at rest (*Astrophysical Journal*, 61, 363, 1925). The sun's velocity relative to this 'world-frame' is about 300 km/sec. in the direction $\alpha = 307^\circ$, $\delta = +56^\circ$. Miller claims that his observations indicate a translation of the sun of at least 200 km./sec. in the direction $\alpha = 255^\circ$, $\delta = +65^\circ$, which point is about 23° from the apex as derived from the asymmetrical distribution and from the globular clusters. As the earth's orbital motion is too small to be detected, there is no way, however, of deciding between two opposite directions.

Even apart from a possible positive effect in the Michelson-Morley experiment, there is another reason for suspecting the existence of a fundamental stationary reference frame. The velocities of the stars are in general less than 500 km/sec, and this is ordinarily explained as a result of the fact that the stars have formerly been more intimately connected than they are now, and that objects of excessive velocities have escaped. But astronomers during the last decade have gone far outside our local star-system, and still we find velocities in general less than 1500 km./sec. The assumption of a selective effect or of an exchange of momenta between *all* cosmical systems may be unnecessary; distant systems may even, in a sense, have an independent origin and still have comparatively small initial velocities, if they are 'born' out of a fundamental medium, the metrical properties of which are the same everywhere. Such a medium and a velocity-restriction would also account for the rigidity of the inertial frame and its coincidence, so far as rotation is concerned, with the stellar frame even for the most distant objects observable. The uniformity in Nature is then due to the uniformity of this medium.

There are, however, several difficulties with regard to the possible interpretations of Miller's experiment. Among these difficulties is the predominant westerly deflexion of the 'ether-drift.' Unless unknown disturbing effects are present, the algebraic sum of the east-west components of the drift during a sidereal day must be zero. Among disturbing effects, besides those due to temperature changes, the effect of a magneto-striction ought to be carefully investigated.

GUSTAF STRÖMBERG.

Mount Wilson Observatory,
January 22.

Nitrogen in the Sun and Stars.

IN a letter in NATURE of February 20, p. 268, under the title "Nitrogen in the Sun," Prof. Saha, in his discussion, refers to the occurrence of nitrogen lines in stellar spectra. He says: "The only nitrogen line which can be identified without ambiguity in the stellar sequence is λ3995. This, however, does not occur in the sun; it occurs, according to [Miss] Payne, first in the A0 class, and Fowler assigns it to N^+." The correction of inaccuracies in these statements may prove of assistance to Prof. Saha in his valuable theoretical deductions appertaining to spectra.

In 1910 the present writer gave ("Researches on the Chemical Origins of various lines in Solar and Stellar Spectra." Publication of the Solar Physics Committee) a list of twenty-nine lines of nitrogen which had been traced in spectra of various subdivisions of the B class. Five of these were, in the stellar spectra, probably blended with lines of other elements, but the remainder were quite free from ambiguity, though a few were weak lines which could not be traced through so long a range in the stellar sequence as the stronger nitrogen lines. Such well-known lines as λλ3995·3, 4447·2, 4630·7 and its four companions on the more refrangible side, are all quite free from blending, the first and third being traced through almost the whole of the B group (B8 to B0) and in ι Orionis of the Oe type, while the remainder were detected only in the shorter range B2 to B0. In addition to occurring in the ordinary stellar sequence, they were observed as absorption lines at certain stages of the spectra of Nova Geminorum by Mr. Stratton, and of Nova Aquilæ by the writer, but in each of these spectra they were enormously displaced to the violet of their normal positions. All the nitrogen lines just mentioned belong to the singly-ionised group designated by Fowler as N^+.

Of the doubly-ionised lines of Fowler's N^{++} class, there is no ambiguity in stellar spectra with such lines as λλ4097·5, 4379·3, 4634·3, and 4640·8. Of these 4097·5 occurs as a weak line at B2 (γ Orionis), is much stronger at B0 (ε Orionis), and apparently attains its maximum intensity in a star of Oe type (29 Canis Majoris), where it is almost as strong as H_δ. This is, however, probably a 'freak' intensity in a star placed, from other considerations, in the Oe class. In other stars of the same named type the line is much less intense. Line 4379·3 is never very strong in stellar spectra, but has been recorded in B2 and B0 types in Kensington publications, and by H. H. Plaskett in O9 and O7 of his suggested classification of O-type stars. It is slightly weaker in 10 Lacertæ (O9) than in 9 Sagittæ (O7), but it is not easy to say where it attains its maximum intensity. Lines 4634·3 and 4640·8 have a different range from the other N^{++} lines discussed here. They have not been traced in any sub-division of the B group. Plaskett records them as absorption lines in O9, and as emission lines in O8 and O7.

All these N^{++} lines occur as emission lines at certain stages of the spectrum of Nova Aquilæ, and probably also in other Novæ. All except 4379·3 have also been recorded in various nebular spectra by Wright. It would seem that the N^{++} class might be further subdivided in the light of their rather different behaviour in stellar spectra.

With regard to Prof. Saha's assertion that, according to Miss Payne, the N line 3995 occurs 'first' in the A0 class, he rather misrepresents her. What she said is: "3995 . . . appears at B0 or earlier, reaches maximum at B5, and is last seen at A0." She was discussing the changes in the line-intensity from B types towards A and later types. This may seem a detail, but in mentioning where a line 'first' or 'last' appears, as Prof. Saha did, it is as well to specify which direction along the stellar sequence an argument is being taken.

It is not here a question, however, of whether the N^{+} lines (3995, for example) are first or last seen at A0, but whether they occur in that type at all. The Harvard type-star for A0 is α Canis Majoris, and in the Harvard tables of stellar lines 3995 does not occur for that spectrum. It was not recorded in the Kensington list of lines for α Canis Majoris, and further search for it in the best spectra available here has not revealed it. It occurs as a weak line in β Tauri (B8), and in β Orionis (B8 Pec.), but that is the latest type in which I have been able to detect it. There is no spectrum of the B9 type in the Cambridge or Kensington collections, but one would rather expect this type to show it as a very weak line. I have always associated these nitrogen lines with the B class of spectra, but never with any subdivision of the A class, and no spectrum has been found here containing the 3995 line which has not the helium lines well-developed. This latter characteristic is not generally associated with A stars, although a few of them (*e.g.* α Cygni) show one or two of the helium lines faintly.

In the light of the table given in the "Harvard Annals," of "Lines in Classes B to B9A" in which the 3995 line is indicated as 'not' occurring in B5, B8, and B9 types (the type-stars for which are respectively φ Velorum, γ Gruis, and λ Centauri), it seems curious that Miss Payne describes it as having its maximum at B5, and as being last seen at A0. It would be interesting to know in which particular spectra of B5 and A0 types respectively the 3995 line fits her statement. Any worker amongst stellar spectra knows that those attributed to a particular type do not always show exactly identical spectra, but it seems almost incredible that two spectra could be allocated to the same sub-division of a group, one showing a certain line at its maximum for the range throughout which it occurs in the stellar sequence, and the other showing no trace of the line at all, without either of them being denoted as 'peculiar.'

Of the spectra available here, 3995 is certainly strongest in γ Orionis, the Harvard type-star for B2.

F. E. BAXANDALL.

Solar Physics Observatory,
Cambridge University, March 7.

The "Gas Laws" in Surface Solutions.

M. ANDRÉ MARCELIN, in a recent paper (*Annales de Physique*, vol. 4, p. 459, 1925) referred to in NATURE of February 13, p. 247, states that the relation between the surface pressure F and area A is, with certain films, of the form of Boyle's law, $FA = kT$; but he states that k is much smaller than the universal gas constant.

Both kinetic and thermodynamic theory predict that at extreme dilution of the films, when the molecules are so far apart that their size and mutual cohesion become negligible, the product FA should be equal to RT, R having the same value of $1{\cdot}372 \times 10^{-16}$ (in c.g.s. units per *molecule*) as in a gas or a perfect solution. If k is much smaller for surface solutions than R, either there must be a great degree of association among the film molecules, or the thermodynamic theory is wrong. M. Marcelin's figures would require an association factor of about 18 for oleic acid on distilled water, and of about 60 for benzyl benzoate. He rejects this as improbable, but suggests an alternative explanation which seems quite impossible; he suggests that owing to movements of the film molecules perpendicular to the surface, a large proportion of them are so far out of the plane of the confining barrier that they do not exert pressure on it. But if they do not exert pressure on the barrier, they must be quite free to pass this barrier; if this is so the number of molecules in the film will be unknown, and the experimental method breaks down altogether.

We find, however, that in the region of pressures and areas covered by M. Marcelin's experiments, the relation between pressure and area is quite different from that reported by him. Our own recently published work (*Proc. Roy. Soc.* A, vol. 110, p. 423, 1926) shows that at low pressures the product FA approaches the theoretical value of $1{\cdot}372\ T$ (areas measured in sq. Å.U. per molecule). At higher pressures the course of the F-A isothermals followed very closely the isothermals for carbon dioxide in the region of the critical point, and indicated the presence in two dimensions of phenomena analogous to evaporation from a liquid film to a gaseous film. There was not, with any one of the compounds, which belonged to four different homologous series, any evidence of considerable association of the molecules before condensation set in. There was a general resemblance between the results on the different series, which indicated that the results are typical of all films. It was possible, however, that the two films on which M. Marcelin worked were exceptions to what we thought was a general law.

We have therefore examined the films of oleic acid on distilled water, and of benzyl benzoate. Benzyl benzoate gave such an unstable film that the surface pressures were evanescent and very small, vanishing almost entirely in about 4 minutes. We think the low pressures in this case are due simply to the molecules not remaining in the film.

With oleic acid, we find the film to be 'expanded' above about 0·2 dynes per cm., when it has an area of 49·7 sq. Å.U. per molecule. There is a fairly abrupt transition from this state into one at which the pressure is constant at about 0·08 dynes per cm., the 'vapour pressure' region. The substance thus behaves very much like the other fatty acids described in our recent paper. Recalculating the results given by M. Marcelin to sq. Å.U. per molecule as unit of area, there is little correspondence; the angle between the vapour pressure region in the F-A curves, and the much steeper 'expanded' curve is obliterated in M. Marcelin's results.

In the following table the results are compared:

Surface Pressure (dynes per cm.).	Areas per Molecule (sq. Å.U.).	
	Marcelin.	Adam and Jessop.
0·5	45	49·5
0·2	112	49·7
0·1	about 230	51·4
0·08	about 300	55 to 660, and probably upwards

The discrepancy is difficult to explain. We feel confident of our results, as the oleic acid was a particularly pure specimen given us by Prof. Lapworth, and the experimental results correspond so well with those of the other acids in our paper; moreover, our results are in accordance with a reasonable theory, which has been recently shown by Schofield and Rideal to include the slightly soluble fatty acids of the saturated series. It is exceedingly difficult to obtain oleic acid absolutely pure; we do not claim that our specimen was perfectly pure, as it probably contained a little palmitic acid. But it may be that M. Marcelin's oleic acid contained some impurity which would obscure the true course of the F-A curve just in this region. If this is so, it is a pure accident that he found the relation $FA = \text{constant}$.

We would also criticise M. Marcelin's experimental method, for his methods of cleaning the surface and handling the films do not seem adequate for quantitative work, with the very sensitive pressure-recording instrument which he describes. In the sensitive apparatus, he describes the float, which bounds one end of the film, as separated from the fixed side boundaries by channels about 1 mm. wide. In our experience even much smaller leaks would be fatal to accuracy, and we close this gap completely, with flexible metal ribbon. Leaks and accidental contamination are serious sources of error in this work, and too great care cannot be taken to discover and avoid these complications.

N. K. ADAM.
G. JESSOP.

The University, Sheffield,
March 6.

Origin of the Fresh-water Fishes of New Zealand.

IN the *Journal of the Linnean Society*, Zoology, 47, No. 313, pp. 99-140, 1925, Oliver has outlined what is virtually a new theory to account for the distribution of South Pacific plants and animals. It is of interest to note that the fresh-water fishes of New Zealand, not included in the above paper, appear all to conform with the suggestions: (1) Their present habits and nature are such that they may easily have crossed small areas of ocean and independent species originated in the separate land masses; or (2) marine species of a restricted habitat have taken to a life in fresh water, changing in form to meet the new conditions. Almost simultaneously Oliver (p. 109) and Skottsberg (*Bishop Museum Bull.* 16, p. 22, 1925) have independently suggested the modification of species and increase in number of forms after arriving at a new region.

Before the introduction of salmon and trout, New Zealand rivers swarmed with species of Galaxias, Anguilla, and other comparatively small fishes, of which the following is a complete list: *Geotria saccifera* Regan, *Geotria australis* Gray, *Anguilla aucklandii* Richardson, *Anguilla australis* Richardson, *Anguilla schmidtii* Phillipps, *Anguilla waitei* Phillipps, *Cheimarrichthys forsteri* Haast, *Gobiomorphus gobioides* (Cuv. and Val.), *Rhombosolea retiaria* Hutton, *Galaxias attenuatus* (Jenyns), *Galaxias fasciatus* Gray, *Galaxias brevipinnis* Günther, *Galaxias huttoni* Regan, *Galaxias kokopu* Clarke, *Galaxias lynx* Hutton, *Galaxias postvectis* Clarke, *Galaxias alepidotus* (Block and Schn.), *Galaxias burrowsius* Phillipps, *Neochanna apoda* Gunther, *Prototroctes oxyrhynchus* Günther, and *Retropinna retropinna* (Richardson).

Oliver suggests that among fish the Galaxiidæ and Geotridæ with headquarters in New Zealand owe their development and distribution to the New Zealand continent, which in former times stretched towards Antarctica. While it is by no means a proved fact that the headquarters of these families were in New Zealand in the Cretaceous period, present conditions would appear to indicate that such may have been the case. Much further investigation of the Geotridæ is required, but in the meantime it seems advisable, from facts I have gathered in regard to growth-changes in the life-history, to admit only two species in New Zealand. These species, *australis* and *saccifera*, are also known from Australia and Chile; but, as the Geotridæ in our rivers are essentially sea-going forms, they may be discarded, together with the Anguillidæ, as offering evidence either in favour of or against former land connexions.

The Galaxiidæ as a family are worthy of mention in that in New Zealand the highest development and the lowest degeneration of the family have taken place. Eleven members of the family are known in New Zealand fresh waters, the young of *Galaxias attenuatus* running from the estuaries of rivers in the spring months and forming the chief constituent of the southern white-bait. Though this species is found both in Australia and South America, it appears to be not nearly so prolific in those countries. Thus, it is quite possible that, in the Cretaceous period, when the New Zealand area was much greater, the Galaxiidæ, which had originated here, then spread to adjoining land masses. The degenerate members of the family are *Galaxias burrowsius* and *Neochanna apoda*, the former having almost lost the use of the ventral fin, while in the latter it has quite disappeared. These fish both hibernate during dry weather and are peculiar to New Zealand.

Gobiomorphus, represented by one species common in all New Zealand fresh waters, has numerous allies among the small Gobiidæ in rock pools on the seacoast. It is almost certainly a descendant of a coastal goby which has taken to a life in fresh water. Turning to Cheirmarrichthys, we note a relative in *Parapercis colias*, the common blue cod of New Zealand; so we may conclude that this species also has arisen independently in the New Zealand area. *Rhombosolea retiaria*, the river flounder, is common in estuaries of large rivers, and on one occasion I have examined an example taken by a trawler in Hawke Bay, New Zealand. There are three common marine species of Rhombosolea around our coasts.

Two species remain to be noted. These are *Prototroctes oxyrhynchus* (the New Zealand grayling) and *Retropinna retropinna* (the New Zealand smelt), each of which is allied to the Salmonidæ of the northern hemisphere, being the only fishes indigenous to New Zealand having an adipose dorsal fin. It is not necessary to erect a continent to explain either of these species; but, as a species of Prototroctes and a species of Retropinna are known in Australian fresh water and not in the sea, it is important that the representatives of Prototroctes and Retropinna in New Zealand rivers enter brackish water, as noted by me in the *New Zealand Journal of Science and Technology* (vol. 6, pp. 115 and 166, 1923). It has never been proved that either of these species has entered the sea. Possibly both Prototroctes and Retropinna originated in the New Zealand area and spread from here to outlying lands. Both species appear to spawn in brackish water, and it is quite possible that the young were formerly capable of crossing short oceanic areas.

W. J. PHILLIPPS.

Dominion Museum,
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The Nomenclature of the Banded Constituents of Coal.

IN view of the wide acceptance in Great Britain of the terms vitrain, clarain, durain, and fusain devised by Dr. Stopes to describe the banded constituents of British bituminous coal, and the introduction of the further terms anthraxylon and attritus by Dr. R. Thiessen, it may be of interest to define the relation between them. At a recent symposium of the Coal Research Club, at which both Dr Stopes and Dr. Thiessen were present, it appeared to be agreed that the two systems have entirely different bases and that each has its validity and use. It was the important service of Dr. Stopes (*Proc. Roy. Soc.*, 1919) to replace the vague terms bright and dull coal by others capable of exact definition. The basis of her system is a lithological one. There are two kinds of bright coal Vitrain is not in itself banded, and has a glassy lustre and conchoidal fracture. Clarain is inherently banded or striated, and consequently scatters light, and has a silky lustre, and does not break with a conchoidal fracture. These purely lithological characters are sufficient to define the terms, without resort to the microscope, a feature essential for practical purposes to retain. Dr. Stopes correlated them with the microscopic and chemical characters, but these are under further investigation.

Clarain, whether derived from a single plant fragment or from general debris, always shows marked structure in thin sections In vitrain the structure, even if not entirely absent, is relatively obscured or obliterated, so that it produces no striation or scattering of light at the surface. Dr. Thiessen's terms, on the other hand, have a botanical, not a lithological basis. It is the contention, first advanced by White and Thiessen in 1913, that the bright laminæ of coal (which from their description must have been vitrain) are always derived from parts of stems and roots. This material Thiessen calls *anthraxylon*. The term suggests 'coal derived from wood.'

Dr. Thiessen perhaps underestimated the contribution of cortical tissues to coal. Miss M. Evans, at the University of Sheffield, has found much vitrain to consist of periderm, and I have under investigation a thick band of clarain consisting wholly of the periderm of a Sigillaria or Lepidodendron. Nevertheless, it is clear that Dr. Thiessen includes in anthraxylon all the associated tissues of stems and roots His generalisation may be expressed in the statement 'all vitrain is anthraxylon.' The converse is not true: all anthraxylon is not vitrain; it may be clarain or even fusain, which Dr. Thiessen describes as 'carbonised anthraxylon.' Nothing could better illustrate the difference between the two systems of nomenclature.

In striking contrast to anthraxylon is the general plant debris, called by Dr. Thiessen attritus. The essential point is that whereas anthraxylon is of homogeneous botanical origin in stems and roots, attritus is of heterogeneous origin in plant debris of all kinds. It is a sort of concrete in which larger fragments (anthraxylon, spore-exines, cuticles, etc.) are embedded in a cement of finely comminuted debris. If the brighter components preponderate, it will be clarain; if the duller ones, it will be durain. The relation between the two systems may be tabulated as follows:

A. ANTHRAXYLON (of homogeneous botanical origin from stems or roots).	A_1 Structure absent, obscured or faint.	Lustre glassy, fracture conchoidal or semi-conchoidal, not laminated.	VITRAIN
	A_2 Structure well preserved.	A_2 I Dull, friable.	FUSAIN.
		A_2 II. Lustre silky, minutely laminated.	CLARAIN.
B. ATTRITUS (of heterogeneous botanical origin, general plant debris).	B_1 Much anthraxylon present.	Lustre silky, minutely laminated	CLARAIN.
	B_2 Little anthraxylon present.	Dull, compact.	DURAIN.

Should it prove that there is a vitrain not derived immediately from portions of stems or roots, this will simply mean that there is a kind of vitrain not contemplated by Dr. Thiessen. The two kinds of clarain could be distinguished as anthraxylous and attrital clarain respectively. Dr. Thiessen uses the adjective 'attritious,' but I do not think it happily formed, and consider 'attrital,' on the model of detrital, to be better.

CLARENCE A. SEYLER.

Nelson Terrace, Swansea.

The Action of Strychnine on the Cerebellar Cortex.

THAT strychnine has a stimulating action on the cerebellar cortex was shown by me a few years ago—(*Science*, 51, 413, 1920). On the application of strychnine to the surface of the *lobulus ansiformis* or cerebellar hemisphere the motor manifestations consist in increased tonus, together with clonus, affecting particularly the ipsilateral hindleg, though affecting also, to some extent, the forelegs and the contralateral hindleg. My positive results obtained with strychnine in the cat agree with those of Shimazono (*Arch. f. mik. Anat.*, 80, 397, 1912), who observed an ipsilateral increase of tonus after applying strychnine to the cerebellar cortex in the pigeon.

It becomes a matter of interest to determine the action of strychnine when applied to the surface of the *lobus anterior*, from which, as Sherrington showed, faradisation yields inhibition of decerebrate rigidity. I have observed that the application of strychnine to this surface results at times in remarkable phenomena: in one instance, the animal (cat) having been decerebrated under ether with the Sherrington decerebrator, 1 per cent. strychnine was applied to the surface of the *lobus anterior*. This quickly resulted in two motor pictures, which alternated regularly: (1) Head and neck dorsiflexed, movements of progression in shoulders, the forelegs being stiffly extended, movements of progression in hindlegs; (2) head, neck, and body flexed ventrally, the hindlegs in violent extension and the forelegs in extension of somewhat less degree. At other times the action of the strychnine on the *lobus anterior* is manifested simply by a heightened intensity of the decerebrate tonus.

A question which obviously demands an answer is whether the application of strychnine to the *lobus anterior* changes in any way the inhibition of decerebrate rigidity elicitable by faradisation of this surface. Bremer (*Arch. int. de Physiol.*, 25, 131, 1925) has already shown that the intravenous injection of strychnine does not modify the inhibitory response.

In my experiments the cat was decerebrated under ether with the decerebrator, and faradisation with bipolar electrodes was applied to the *lobus anterior*. There resulted the typical inhibition of the tonus in the forelegs; 1 per cent. strychnine nitrate was then applied; this resulted in some increase in the tonus of the forelegs. On repeating the faradisation, inhibition of the tonus was again evoked, the effect being, however, slightly less pronounced than before the application of the strychnine; then followed an augmented tonus (rebound), which was greater than before the application of the strychnine. These observations were repeated a number of times after several applications of strychnine and always with the same result.

Clearly we must conclude that strychnine applied to the cortex of the *lobus anterior* does not reverse, though it reduces slightly, the inhibitory response which can be elicited therefrom; the subsequent rebound is somewhat enhanced, a modification of the same kind as that noted by Bremer after intravenous injection of strychnine. The question as to why strychnine, though apparently exciting the cortex of the *lobus anterior*, should evoke an augmented instead of a diminished tonus, as does faradisation, remains for the present undecided.

FREDERICK R. MILLER.

Medical School,
University of Western Ontario,
London, Canada, February 20.

The Relationship between Viscosity of the Blood and Shock.

IN a series of experiments in which solutions of peptone or histamine were injected intravenously into rabbits I have observed that, accompanying the fall in blood-pressure and other anaphylactoid phenomena, there is a marked reduction in the viscosity of the blood. I consider that this lessened viscosity is the primary cause of the fall in blood-pressure and the accompanying symptoms of shock. That a fall in blood-pressure can be produced by a reduction in the viscosity of the blood was proved by Bayliss (*Proc Roy. Soc.*, 89, 380, 1917), who proved that on bleeding an animal and afterwards injecting a corresponding amount of saline, both blood-pressure and viscosity show parallel reductions.

In my experiments, rabbits were anæsthetised with ether and urethane. Blood-pressure was recorded from the carotid artery and samples of blood were drawn from the femoral artery before injection of the peptone or histamine, and at intervals following the injection. The viscosity of these samples was determined by a viscosimeter of the Oswald type, the temperature being kept constant during the observations. The peptone or histamine, dissolved in physiological saline, was injected into the external jugular vein.

Following the injections, an immediate fall in blood-pressure was observed and the animal showed symptoms of shock. Examination of the blood showed that the viscosity was diminished. As a control, the experiments were repeated, with the difference that the peptone or histamine was dissolved in saline gum acacia solution of the same viscosity as blood; while the decrease in viscosity following these injections was not quite so great as in the former experiments, it was nevertheless very marked.

It seems plausible, then, to conclude that the fall in viscosity is produced by the peptone or histamine *per se* and not by the small amount of solvent in which it is dissolved. In conclusion, I wish to express the view that the anaphylactoid phenomena observed following the injection of peptone or histamine owe their origin primarily to the lessened viscosity of the blood and the resultant diminution in blood-pressure which are induced by the injections of these substances.

Viscosity determinations of the blood of sensitised guinea-pigs before and after injections of the provocative dose are now being carried out. The results indicate a definite decrease in viscosity following the injections.

RUSSELL A. WAUD.

Department of Physiology,
University of Western Ontario,
London, Canada, February 25.

Domestic Heating.

IN her letter in NATURE of March 6, p. 343, Dr. Stopes affords no evidence that the beneficial effects which she says she derived from the glowing coal fire were due to coal. She might have got equally good effects from a *glowing* coke fire, gas fire, or electric heater. She compares the effect of lying naked in front of a glowing coal fire with stripping in a warm room. Advantage lies in the use of a visible source of radiation.

This winter's experience has shown us that the close-up use of electric lamps in the Zoo has made a great difference to the marmosets, iguanas, etc. Dark heat does not suffice to keep such animals alive. We, and they, need visible rays which penetrate to, and are absorbed in, the blood beneath the epidermis, the red rays penetrating still deeper, and ultra-violet rays, which are absorbed in the epidermis, the energy of all these rays being converted in living cells. Dark heat is absorbed by the water in the surface layer of the body—quite another thing. While there is no evidence of any mysterious health-giving property in a coal fire, such as Dr. Stopes imagines, by polluting the atmosphere it causes great economic loss, and by screening off sunshine lessens health and happiness. We should therefore take to smokeless fuels, keeping to visible sources of radiation which are not only healthy but also adaptable to our changeable climate.

LEONARD HILL.

Osborne House, Loughton,
March 12.

Chemical Society Publications Fund.

IT is a welcome sign that research work in chemistry emanating from our universities continues steadily to increase. Pessimists told us that the increase which followed the War was due to abnormal conditions and that the apex of the curve would soon be reached. Fortunately for our chemical well-being, this is not the case and the curve continues to rise. Unfortunately, the costs of printing do not diminish and the financial burden on publishing societies continues to grow.

In order to ease the burden, the Chemical Society has raised a Publications Fund which, through the generosity of fellows of the Society and chemical manufacturers, now approaches 5000*l.*; but the income from this is still too small to be really effective.

The Society acts as a publishing body for the universities, and does so freely in the interests of chemical science. Nevertheless, it is gratifying to record that one university, namely, that of Birmingham, by subscribing 100*l.* from its research fund to the Publications Fund, has recognised the work the Society is doing for it and for academic institutions in general. *Venienti occurrite morbo.*

JOCELYN THORPE.
(Treasurer.)

Chemical Society,
Burlington House, London, W.1,
March 13.

The Modern Boiler-House.

By Eng.-Capt. Edgar C. Smith, O.B.E., R.N.

FEW departments of engineering practice have seen more radical changes than that of steam raising. Stokeholds of ships and power stations have been transformed. Where dirt, confusion, and inefficiency often reigned there is now order and method, and brawn and muscle have made room for skill and trained intelligence. Science has come into its own, and the modern boiler-room reflects the progress of the time. Installed in well-lighted and spacious buildings, the boilers and all their accessories are the objects of the care of the engineer-in-charge as much as the main machinery itself. Water-tube boilers, super-heaters, economisers, air heaters, mechanical stokers, pulverised fuel systems, forced and induced draught fans of many types have taken the place of tank boilers fired by hand, while new forms of gauges and indicators keep continuous records of the fuel consumed, the analyses of the gases, the temperatures of gases, steam, and water, and, in some instances, steam-flow meters are fitted which make the approximate test of a boiler a comparatively simple matter.

The most advanced boiler practice is to be found in the electric power stations. Of such stations there are in Great Britain nearly six hundred concerned with the public supply of electric current, but the majority of them are small. Those at Barking, Manchester, Birmingham, Glasgow, Newcastle, and a few others are of considerable size; but it is in the United States we see the rise of the so-called super-power station—a super-power station being essentially a very large plant comprising a part of a regional system wherein the more efficient plants are linked up. Electricity is used in America to a far greater extent than in the old world, and as much current is generated in the United States as in all the countries of Europe combined. Some striking figures and diagrams regarding the electrical industry is given in the January issue of the *Electrical World*, where it is stated that the power distributed in the United States last year amounted to 54,413,000,000 kilowatt hours, the corresponding figure for Great Britain being 6,681,000,000 kilowatt hours. Other interesting details regarding the super-power stations were also recently given by Mr. W. H. Patchell in his honorary members' lecture to the Junior Institution of Engineers. Mr. Patchell has himself been connected with power station work for the last forty years, and he was the pioneer of the very large boiler.

Modern power station boilers are invariably of the water-tube type, among the most popular being the Babcock and Wilcox and the Stirling. Pressures in such boilers have gradually advanced until to-day 300 lb. and 400 lb. per square inch is common, while there are stations using steam at 500 lb., 600 lb., 800 lb., and even 1200 lb. pressure. Boilers are also made in very large units. Copper, brass, wrought iron and steel have all been used for boiler tubes, which formerly were made from sheets rolled and welded; but thanks to the invention of the German metallurgist, Mannesmann, boiler tubes now are of solid drawn steel, and with such tubes failures are infrequent.

The stoking of the boilers is done by one of two types of mechanical stokers known as chain-grate stokers and under-feed stokers, or the coal is pulverised and blown into the furnace by jets of air. In chain-grate stokers the coal is fed from a hopper on to an endless chain of short fire-bars linked together, the grate travelling slowly into the furnace at about 2 to 6 inches per minute. With such stokers, firebrick arches are employed to reflect the heat from the fire and assist the combustion of the gases. The ash falls off the chain grate at the back of the furnace and is conveyed away by various means. The size of a large chain grate may exceed 20 feet square. In an under-feed stoker the coal is fed into the furnace by retorts and is thrust up under the already burning coal, the fuel being agitated by reciprocating fire-bars. Thick fires are the practice with under-feed stokers. Many types of mechanical stokers are in the market, and the choice is determined largely by the class of coal to be burned.

The most interesting development in boiler firing is the comparatively new system of using coal dust. In this case the coal is crushed, then passed through a magnetic separator to remove pieces of stray iron, and, after being dried in steam or hot-gas driers, is pulverised in mills to such a fineness that most of it will pass through a sieve with a mesh of $\frac{1}{100}$ of an inch. From the mill it is conveyed to bunkers, from which it is delivered to the burners. In a plant using pulverised fuel the lower drum of the boiler may be some 20 feet or more above the ground floor, the walled-in space beneath the boiler constituting the furnace or combustion chamber. So large are some of these combustion chambers that it would be possible to place a two-storeyed double-fronted villa in one of them. The coal dust is injected into the chamber through nozzles pointing downwards from a position corresponding to the cornice of a ceiling. The very high temperatures reached have called for improvements in refractory materials for the walls of the combustion chambers, but a promising experiment has been made by forming the walls of water-tubes with longitudinal fins welded on them. With pulverised fuel the ash falls as minute drops of liquid slag. A screen of water-pipes placed about a foot apart across the bottom of the combustion chamber cools these drops, and the ash reaches the floor as fine dust, which is easily dealt with.

An integral part of every modern boiler is the super-heater through which the steam passes on its way to the engine. Super-heating is now in use in ships and locomotives as well as in power stations, and there is a rough rule that 10° F. super-heat leads to an economy of 1 per cent. in the fuel.

After the gases have passed among the boiler and super-heater tubes they are still at a moderately high temperature, and are therefore caused to flow through an economiser for heating the feed water and through a pre-heater for heating the air for the furnaces. Finally, at the top of the boiler-house, they are drawn into the induced draught fan and ejected into the chimney-stack.

A modern boiler-house is a steel-framed structure of three or four storeys, perhaps 100 feet in height. Platforms at intervals support the various sections of the plant, and gratings and ladders give access to the stop-valves, gauges, burners, and other fittings. Roomy and well lighted inside, the buildings are designed by architects especially qualified in such work, and the exteriors are both pleasing and appropriate.

Super-power stations each designed for an ultimate capacity of over 300,000 kilowatts, have already been erected at St. Louis, Chicago, Pittsburg, New York, Brooklyn, Detroit, Boston, Cincinatti, and one or two other places, and a few particulars of some of their boiler plants may be of interest.

What will probably be the largest station is the Crawford Avenue station of the Commonwealth Edison Co., Chicago, and it was for this station Messrs. C. A. Parsons and Co. constructed the fine 50,000 kilowatt turbo-generator, the model of which was shown at the British Empire Exhibition at Wembley, from whence it was removed to the Science Museum, South Kensington. A full description of this set is in *Engineering* for March 5. The ultimate capacity of Crawford Avenue will probably reach 800,000 kilowatts. Very large Babcock and Wilcox boilers are installed, the tubes being 15 feet long, while the steam drums are 4 feet in diameter and 32 feet long. The drums are of steel plates 1⅞ inch thick, and the riveting is of an exceptional character. Forced draught chain grates are used, the grates being 24 feet wide and 20½ feet long. Steam is generated at 600 lb. pressure and delivered to the turbines at 550 lb. pressure at a temperature of 725°. About 190 tons of steam per hour is required for the single 50,000 kilowatt Parsons set. The boiler-house also contains a reheat boiler through which the steam is caused to pass on its way from the H.P. turbine to the I.P. turbine. The steam leaves the H.P. turbine at 100 lb. pressure and at a temperature of 425° F., and enters the I.P. turbine at about the same pressure but with its temperature increased to 700° F. Economisers are used, but the feed water, before entering the economiser, has already passed through five steam heaters, with the result that it enters the economiser at 315° F. and leaves at 380° F. At Crawford Avenue full advantage is made of the modern system of 'bleeding' the turbine.

Another large plant is that of the Detroit Edison Co., which supplies electricity over a very large area and sells it to the farmer 50 miles away at the same price as to the town dweller. The company has stations at Delray, Connor's Creek, and Marysville, and a new station has recently been erected at Trenton Channel. The Stirling boilers here work at 410 lb. pressure and the steam is super-heated to 700° F. Pulverised fuel is used entirely. A section of the boiler-house shows the ash-shoot at the ground level, the boiler floor 45 feet above this, and the roof 130 feet from the ground. Standing in the huge combustion chambers, the ash-shoots are at one's feet while the boiler tubes are some 50 feet overhead. The volume of such a combustion chamber is about 25,000 cubic feet, and one boiler will supply sufficient steam for a 25,000 kilowatt machine. At present there are three 50,000 kilowatt turbo-generators installed. Electricity is generated at 12,000 volts and distributed by overhead mains at 120,000 volts.

With the reputation of having established a record in economy, the Philo Station at Zanesville, Ohio, is a station possessing many remarkable features. It forms one of the plants of the American Gas and Electric Co., and was designed "to produce a marketable commodity at the lowest possible price." The thermal efficiency of the plant worked out at 23·81 per cent. The boiler pressure is 650 lb. and the steam temperature 750° F. In addition to the main boilers there are super-heaters, economisers, air heaters, forced and induced draught fans, and a reheat boiler as at Crawford Avenue. This station is unique in that it is able to draw its circulating water for the condensers from a reservoir at a higher level than the machinery, and for ten months in the year, therefore, no circulating pumps are required. Philo is but a link in a great system supplying electricity to parts of Ohio, Indiana, Pennsylvania, and West Virginia.

All records of boiler pressures in actual use are surpassed by the 1200 lb. pressure generated in the remarkable Babcock and Wilcox boilers at Calumet and at the Edgar station, Boston. At Boston three large boilers provide the main steam supply at 350 lb. pressure, but there is a separate boiler working at 1200 lb. pressure. This very high pressure steam is first used in a 2500 kilowatt turbo-generator, from which it exhausts to a reheater and then finds its way into the 350 lb. main of the station. The steam drum of the 1200 lb. boiler is an exceptionally fine piece of work. It was made from a steel ingot weighing about 100 tons. The ingot was 'upset' until about 8 feet in diameter, a core of 23 inches was then removed from it, and by subsequent operations the ingot was drawn out into a drum 34 feet long and 4 feet in diameter, the walls of which were 4 inches thick. Such work is within the capacity of only a few firms, but it well illustrates the demands made on the manufacturer by the designer of modern boilers.

Trends in American Geology.

In an address delivered to Section E (Geology and Geography) at the recent meeting of the American Association for the Advancement of Science, Dr. W. C. Mendenhall dealt with "Some Recent Trends in American Geology," indicating the lines along which, according to his view of the matter, effective progress in the science of geology is being made. Modern science, said Dr. Mendenhall in his opening remarks, is too broad and too complex to be comprehended by any individual, and any one of the sciences is beyond the grasp of one man. "Progress is made by the specialist or group of specialists who devote themselves to a limited field. Presently there comes out of their endeavours a generalisation which can be used by other groups. Thus the advances in different fields are linked together and a united front is maintained."

Study of Sediments.

A promising development of the last few years is the revival of interest in the petrology of sediments and the organised attack that is being made on the problems connected therewith. The United States National

Research Council has appointed a Committee on Sedimentation under the chairmanship of Drs. Vaughan and Twenhofel. Under the guidance of this committee it is proposed to issue a treatise on sedimentation for the purpose of directing attention to the research problems involved. Laboratories for the study of sediments are being installed in various institutions, and new courses are being organised in several of the universities. Already, scientific papers are being published on this subject, and petrographers are ceasing to find their sole interest in igneous problems. It is expected that the influx of new data arising from these investigations will have much influence on the study of palæogeography by throwing new light on the climatic and other conditions under which sedimentary rocks have been formed.

GLACIAL HISTORY.

Two conspicuous tendencies are displayed in this branch of study; one towards the establishment of a more definite chronology in glacial events, the other towards linking up these glacial events more closely with pre-glacial history. In this connexion perhaps the most striking and best-known quantitative attack is that of Dr. Antevs, who, with the assistance of the Canadian Survey, Harvard University, and the Carnegie Institution of Washington, is applying the methods of Baron de Geer to North American problems.

STRATIGRAPHY AND PALÆONTOLOGY.

In these departments there has been a large increase in the amount of available data, which has been collected by more refined and exact methods, and on that account has made possible more definite correlations and more exact interpretations of the physical environment in which strata have been formed. In the light of this newer data, old problems like that of the Laramie problem are vanishing, and strata, the ages of which have long been considered doubtful, are taking their places in the normal sequence. Ulrich has recognised in America two large and extensively developed assemblages of Lower Palæozoic rocks which he thinks deserve to rank as systems, although they are but meagrely represented in the classical localities of north-western Europe. Much progress is being made in the study of the smaller fossils, especially in oilfield stratigraphy, and the research now being carried on in this connexion is expected to lead to interesting results and useful developments in the near future.

PETROLEUM GEOLOGY.

The last decade has witnessed a large absorption of geological talent by various oil interests, consequent upon recognition by the latter of the fact that the science of geology is an essential weapon in the attack on problems of oilfield exploration and development. This has led to a rapid development of the more obviously favourable areas. The exploration of less favourable areas requires more refined methods, in the application of which the more alert organisations are engaging physicists, chemists, palæontologists, and more geologists in order to cope with the difficulties involved in the maintenance of supplies of oil.

The solution of the problem of the distribution of petroleum in the earth is one involving many hindrances and difficulties. In spite of the excellent forum offered by the American Association of Petroleum Geologists and its journal, there is not complete freedom in the interchange of ideas, owing to the fact that some companies hesitate to give the world the full benefit of results which they have been able to obtain only at much expense. There is, moreover, the further difficulty that any particular company or group is often hindered by commercial considerations from taking a large view of the research aspects of the problems it has to deal with. It is hoped, however, that oil companies will soon come to realise more fully how much might be done for the advancement of knowledge by exploiting more fully the opportunities that already exist. Leaders among petroleum geologists are fully aware of these opportunities, and their co-operation, on one hand with the oil-company executives, and on the other with various non-commercial scientific organisations, is expected to have fruitful results. The American Petroleum Institute recently announced that John D. Rockefeller had provided a fund for petroleum research. It seems likely, therefore, that the next decade will see large advances in knowledge concerning the origin of petroleum and the extent of the United States petroleum resources.

ORIGIN OF COAL.

The results of a combined attack by geological, chemical, and physical methods upon the problems of the origin and classification of coal has tended in recent years to confirm the old belief that coals of different kinds have a common origin, and that they represent different stages in the metamorphism of peat, material differences among coals being due to differences in the nature and relative amounts of the various original plant-debris constituents. A notable outcome of these researches into progressive carbonisation has been its use by Dr. D. White as an indicator of the extent to which the beginnings of metamorphism in rocks has gone, and the practical application of this indicator in determining areas in which the survival of liquid and gaseous hydrocarbons may be expected. Research is now being undertaken to ascertain whether a study of carbonaceous sediments other than coal can be turned to similar account, so that in the absence of coals it may still be possible to predict whether any petroleum that formerly may have been present in a region has survived.

SEISMOLOGY.

In this field of work, a co-ordinated effort is being made by the Seismological Society, the Carnegie Institution of Washington, the Research Council, the Coast Survey, the Geological Survey, and many universities and individuals, to collect facts from which it may be possible to define seismic and non-seismic areas, and to classify the former according to their degree of seismicity. The aim of this work is to ascertain how far it may be possible to predict the immanence and locus of earthquake shocks, so as to be prepared in some measure for their occurrence. This work will derive stimulus and support from business interests. Already it is a broad business problem, the approach being mainly from the point of view of insurance.

Ore Deposits.

For a generation or so, according to Dr. Mendenhall, this branch of geology has brought forth no such universally accepted generalisation as appeared in the preceding period. A large amount of data has been accumulated, however, and the possibility of interpreting these data by scientific principles has been actively tested for the purpose of solving the important economic problems of ore-finding and mine development. A growing consciousness of the prospective shortage in supply of the precious metals, as well as some of the base metals, has led to attempts to survey broadly the whole field of mineral supplies, to see whether, from the detailed studies that have been made already, any general laws can be deduced that will prove helpful as a guide to means of increased production. In this connexion there has been in recent years a growing appreciation of the international aspect of the problem of mineral supplies.

As Dr. Mendenhall fully realises, however, this, and other of the topics he deals with, relate to applied rather than to pure geology; and, unless one is satisfied that geology is a perfected science, it seems needful that the fundamental principles of the science should receive attention; for science has to be established before it can be applied. Is sufficient being done for the principles of geology by the present generation, and is adequate progress being made towards the unity and co-ordination of the various specialised branches of geology? Dr. Mendenhall assures us that the trends in American geology show that sound and substantial progress, impressive in the aggregate, is being made. His rather optimistic view of this matter is defined in his opening remarks, as already mentioned, to the effect that progress in the science as a whole is made by the maintenance of a united front by bands of specialists, each ploughing its rather lonely furrow. We may, however, reasonably doubt whether bands of specialists are capable of moving forward on a united front without some generalship in the way of fundamental scientific principles to guide them.

Looking at the subject from a less appreciative point of view, and presumably more as a student of principles than of details, President Lowell of Harvard said not long ago that for many years geology had taken no forward step. In his address last year as president of the Institution of Mining and Metallurgy, Sir Thomas Holland voiced a similar view. These differences of opinion as to whether geology is making progress clearly depend upon the viewpoint we take. Looking at the matter from a specialistic point of view, Dr. Mendenhall is no doubt right in claiming that there has been movement. Viewing it more generally, President Lowell is no doubt equally right in claiming that such movement as has taken place does not constitute progress. Anyhow, it seems desirable enough that geologists should keep well in mind the need that exists for the cultivation of scientific principles as well as specialistic details, for only by so doing will it ever become possible either to raise the status of geology as a science, or to cope with the many difficult problems, both scientific and economic, that await solution. T. C.

British Association at Oxford.

Preliminary Programme.

The preliminary programme of the British Association meeting in Oxford on August 4-11 has been issued from the office of the Association at Burlington House. It indicates that the presidential address by the Prince of Wales is expected to deal, among other matters, with relations between scientific research, the community, and the State, both at home and in the overseas Dominions. The address will be delivered, at 8.30 P.M. on August 4, in the Sheldonian Theatre, but as the accommodation there is not expected to suffice for so large a meeting, the proceedings will be relayed to the Town Hall, and, if necessary, to the Union Society's Hall or elsewhere.

The subjects of a number of the addresses by sectional presidents are announced. In the mathematical and physical section, Prof. A. Fowler will deal with the production and analysis of spectra; and spectroscopy is likely to be an important subject of discussion in this section. Prof. J. F. Thorpe will address the chemical section on the scope of organic chemistry, and Prof. S. H. Reynolds the geological section on progress in the study of the British Lower Carboniferous rocks. In the zoological section, Prof. J. Graham Kerr will speak on biology and the training of the citizen. The Hon. W. Ormsby-Gore will bring the first-hand experiences of his African tours to bear in discussing the economic development of British tropical Africa, in the geographical section. Sir Josiah Stamp will address the section of economics on inheritance as an economic factor. In the engineering section, Sir John Snell will deal with the recent and probable future development of the electricity supply. Prof. H. J. Fleure, in the chair of the anthropological section, will review the modern position in regard to knowledge of the evolution of human races; and Prof. J. B. Leathes, addressing the physiological section, will deal with function and design. Announcements received since the programme went to press include that of Sir Daniel Hall's address to the agricultural section; his subject will be the area of cultivation required to feed the population. Prof. F. O. Bower, who succeeds the late Dr. W. Bateson as president of the botanical section, will review the state of botanical science at the present time in comparison with that at the Oxford meetings in 1894 and 1860. One of the evening discourses will be given by Prof. A. S. Eddington, and a large number of discussions on leading scientific subjects have already been arranged. On Thursday, August 5, there will be two on important Imperial topics—educational training for life overseas, and the effect of contact with European civilisation upon African native races.

The Vice-Chancellor of the University of Oxford and the Mayor of Oxford will hold receptions, and the local executive committee will give a conversazione, with the co-operation of the Junior Scientific Club. A number of excursions to places of interest are also being arranged. Among preachers at the cathedral and principal churches on the Sunday during the meeting will be the Bishops of Oxford and Winchester, the Dean of St. Paul's, and the Master of the Temple, and at Mansfield College, Dr. Selbie, the principal. Assistance is offered by the local committee to members desirous of obtaining accommodation, during the meeting, in colleges, hostels, lodgings, and private hotels, and there should be no lack of room for visitors, provided (but the proviso is important) that early application be made on the form sent out with the programme.

News and Views.

WE note with pleasure the appointment of an engineer officer of the Royal Navy as a Naval A.D.C. to the King. This is the first time this honour has been bestowed upon a naval engineer. The officer selected is Engineer Captain E. P. St, John Benn, who is at present in command of the Royal Naval Engineering College, Keyham. The College, it will be remembered, was opened in 1880, but owing to the changes due to the Selborne scheme of training the direct entry of engineer cadets ceased and for some years the College was closed. It was reorganised in 1920 and midshipmen from Dartmouth and special entry cadets for the Engineering Branch now enter it for a four years' course of training in mechanical and electrical engineering. Captain Benn's appointment is the direct outcome of the representations made by the Engineering Institutions to which we have already referred, and to which the Duke of Northumberland alluded in his presidential address last week to the Institution of Naval Architects. In the course of his remarks the Duke of Northumberland said that in the opinion of the Institution it was an anachronism to emphasise the difference between the executive officer and his engineering colleague, and that it was felt that if a place could be found in the Board of Admiralty for direct representation of the engineering branch it would certainly tend to make engineers confident that their views would be fully considered. With these views we are in entire agreement

THE Hon. Robert Boyle remarked that "it may much assist us to take notice of the multitude of Effluvia, and make us expect great matters from them," and the chief conclusion reached in the course of some investigations recently undertaken for the *Forum*, and described by Mr. E. E. Free in the March issue of that journal, is: "that a conscious effort to train our national noses might have a distinctly worth-while effect on the comfort of living." A similar conclusion has been arrived at by quite a number of investigators; reference may be made to various papers on the subject listed in "Osmics" (Oliver and Boyd, Edinburgh, 1922, 1924). The conclusion is strengthened by finding that the percentage of correct identification of the odours used in these tests is only 21·2, and in a group of students at Dartmouth College, 37·4, whereas a trained pharmacist identified correctly eleven out of twelve odours submitted. The conclusion that people do not differ greatly in their olfactory acuity is somewhat vitiated by the circumstance that the paper does not reveal the employment of exact olfactometric methods, the odours being merely referred to as very weak, weak, moderately strong, and strong. While Henning's method of classifying odours is criticised, there is no mention of Zwaardemaker or Heyninx. "We found a complete absence of indication that any primary list exists at all. So far as we can determine from our tests each odour is smelled individually and all of them unlike each other." This conclusion may be due to the small number of odours employed, as well as to the circumstance that association by similarity involves more elaborate neuron patterns than association by contiguity. Various instances are given of affects and associations due to odours, and Mr. Free concludes that smells are largely recognised by their associations. The value of the paper would seem to lie in the plea for training the sense of smell, and perhaps, too, in emphasising the value of previous work on the subject, for example by Titchener, Vortriede, Harris, and others, not to mention Dr. Dan McKenzie's "Aromatics and the Soul," which Mr. Free would find to be an excellent introduction to the subject he has written about.

IF it can be shown that those who launch a new scientific journal are justified in their claim that it can indeed contribute to the welfare of the science that it is meant to serve, then even those who bemoan the increase of publications will welcome it. In the foreword to the first number of the *Quarterly Review of Biology*, Prof. Raymond Pearl, the editor, gives adequate reasons for adding yet another to the 25,000 already existing reputable scientific journals of the world. The new journal is addressed primarily to all men of science who wish to keep soundly orientated as to the general progress of biology, but it is intended further to be an effective answer to the menace of Fundamentalism, which is best met by the diffusion of scientific knowledge among intelligent men and women who are not professionally scientific workers but are genuinely interested in the advances that are being made. The journal, which costs 5·50 dollars a year, is published by the Williams and Wilkins Company, Baltimore; the associate editor is Prof. R. W. Hegner, and the advisory board includes fifteen of the best-known American biologists, most 'specialisms' being represented. The first number includes the following papers: "The Biology of the Mammalian Testis and Scrotum," by C. R. Moore; "Symbiosis among Animals," by L. R. Cleveland; "Experimental Studies on Morphogenesis in the Nervous System," by S. R. Detwiler; "A Review of the Discovery of Photoperiodism," by K. F. Kellerman; "Recent Discoveries in the Biology of Amœba," by A. A. Schaeffer; reviews of seventy-seven new biological books, including a long critical one, by J. H. Gerould, of Cuénot's "L'adaptation." The articles are written by acknowledged authorities capable of presenting accurate, balanced, and critical summaries of the present position of their own particular fields. The list of papers to appear in future numbers is such as would seem to indicate that the success of this new journal is assured. It is but fitting that Prof. Raymond Pearl, who by his outstanding ability and almost superhuman energy has, in the past, set such a pace in biological research that few of us could keep up with him, should, by producing the *Quarterly Review of Biology*, enable us 'to get our second wind.'

THE Report for 1925 of the Marine Biological Station at Port Erin, Isle of Man, drawn up by Prof. Jas. Johnstone, shows a very satisfactory state of affairs and a large amount of work has been accomplished both by the resident staff and by occasional workers. The fish hatchery has yielded more than three million plaice larvæ which have been set free into the sea, and of the parent stock not one died, all being in good condition. More larval lobsters were reared than in any previous year. From fifteen lobsters 526 lobsterlings, fed on fresh plankton, were reared in jars, 500 of these being set free into the sea besides many thousand younger larvæ. The naturalist of the Laboratory, Mr. J. Ronald Bruce, has published an interesting paper on the "Salinity and Carbon Assimilations in Amphidinium" in the *British Journal of Experimental Biology*, and proposes further instalments of this important work on the metabolism of the shore-living dinoflagellates, which on the Port Erin sands offer special facilities for such studies. He is also investigating the seasonal variations of the gaseous metabolism in the common mussel. From the oceanographical department of the University of Liverpool, Mr. R. A. Fleming publishes "Notes on some Fish landed from the South-Western Hake Grounds," the fish, chiefly sharks, having been sent to the Laboratory for researches into their liver-oils, and Mr. R. J. Daniel describes a large and perfect Stenoteuthis measuring six feet including the tentacles, taken in the trawl off St. Kilda. Dr. Margery Knight, from the botany department of the University, reports on the investigations on Algæ undertaken by herself and pupils—research covering a wide area which promises to yield important results only obtainable by methodical team-work and keen workers both in the laboratory and on the sea-shore. The absence of a research boat at Port Erin is certainly to be deplored, and it is hoped that this gap will be filled at the earliest opportunity.

IN 1923 the Government of Finland issued invitations for a conference of delegates from the States which border the Baltic in order to discuss the desirability of common action whereby a chain of first order triangulation round the Baltic shores might be carried out. The conference met at Helsingfors at the end of June 1924, and was attended by representatives of Esthonia, Finland, Germany, Lettonia, Lithuania, Poland and Sweden. A report has now been issued (*Comptes Rendus des Séances de la Conférence Géodésique réunie à Helsingfors*, Helsinki, 1925). The discussions which took place were essentially of a technical character, and a number of resolutions were adopted with the view of ensuring the work being homogeneous, and of a uniformly high standard of accuracy in all portions of its circuit. A considerable portion of the chain is already in existence in various countries, but the additional extensions and connexions which will be required were discussed and agreed upon. In such new work the mean length of a side of a triangle is to be about 30 km. and no angle is to be less than 30°; heliotropes or lamps are to be used as signals except where the sides are short. The instrument recommended was a theodolite having divided circles of 20 cm. diameter and reading to 2″. Six additional bases are to be measured at various points of the chain with Jäderin wires which are to be verified by measurements made on a selected control base. Astronomical determinations of latitude, longitude, and azimuth are to be made as often as practicable, and it was agreed that Laplace stations should in any case be not more than 200 km. apart. Considerable emphasis was laid on the importance of gravity determinations, which are to be made as frequently as possible. Von Sterneck's pendulum apparatus is to be employed, and those used will be standardised at Potsdam. The publication not only summarises briefly the plans which have been made for carrying out this important piece of European geodesy, but it also furnishes a convenient abstract of the operations which have to be carried out in a piece of modern geodetic triangulation, and of the accuracy which is required at the various stages of the work

WE have received three volumes of the final report on the Japanese earthquake of 1923. They belong to the series of Reports of the Imperial Earthquake Investigation Committee printed in Japanese, and it is much to be hoped that before long they will appear in English in the corresponding series of Reports in Foreign Languages. If we may judge from the tables of contents and the numerous and admirable plates, the complete report on the earthquake will assuredly take its place as one of the finest accounts that we possess of any natural phenomenon. The first volume (No. 100, A) is mainly concerned with the earthquake in general and its after-shocks, and with the distribution of intensity in various districts; the second (No. 100, B) with the geology and physiography of the central area, the changes in the level of the land and of the floor of Sagami Bay, and the sea-waves following the earthquake; and the third (No. 100, E) with the great fires in Tokyo and other places. Among the plates may be specially mentioned the detailed chart showing the changes in the bed of Sagami Bay, the seismograms from Tokyo and elsewhere, the mareograms from many Japanese ports, and the map showing the isoseismal lines bounding places in which the percentage of collapsed houses reached 30 and 5, respectively. Yokohama lies within the former curve, and the greater part of Tokyo outside the latter.

The Weather Bureau of the U.S. Department of Agriculture has issued "Instructions to Marine Meteorological Observers" (W.B. No. 866). For ocean meteorology the Weather Bureau asks for one regular observation a day at noon, G.M.T. In certain designated areas from which observations are transmitted by radio-telegraphy, an additional regular observation is asked for at midnight, G.M.T. The reason for making observations at the same moment of time is for the construction of synoptic weather charts of large areas. For the transmission of observations by radio a separate publication, "Radiographic Weather Code for Vessel Weather Observers," is issued. Instructions for taking observations are printed in English, French, German, Italian, and Spanish. The requirements for observations are much the same as those of the Marine Branch of the British Meteorological Office, and the observations obtained are similarly used. Good explanations and illustrations are provided of the various instruments as well as of clouds and other weather observations, together with maps showing the use of synoptic observations over the Atlantic. A glossary is given of a number of meteorological terms of special interest to mariners and tables for the correction and reduction of observations.

The report of the Botanical Survey of India for 1924–1925, issued by the Director, Mr. C. C. Calder, is melancholy reading in one sense in that it states that owing to reduction in staff, effected "to secure the object of retrenchment," the Survey, "so far as field exploration is concerned," became "a Department in name only." On the other hand, much good systematic botanical work is chronicled by students of Indian botany both in India and abroad. An interesting report is also given of a further year's experimental work with cinchona in Burma. The Director concludes his account of the Burma plantations with the forecast that, if labour conditions are favourable, he sees no reason "why a large quinine producing belt extending from the Tenasserim River eastwards to the borders of Siam should not result and production on a scale sufficient to affect controlled prices and bring the drug within the reach of India's malarial millions."

The address given by M. Daniel Berthelot at the formal meeting of the Society of Civil Engineers of France, with the President of the Republic in the chair, held in celebration of the centenary of the publication of Carnot's tract "sur la puissance motrice du feu," is given in full in the issue of the *Revue Scientifique* for February 13. Born in 1798, Nicolas-Leonard-Sadi Carnot was only twenty-eight years of age when his brochure of 118 pages was published by Bachelier of 55 quai des Augustins, and eight years later he was carried off by an epidemic of cholera. In conformity with the sanitary regulations his effects were burnt, a small exercise book with scientific notes, now in the archives of the Paris Academy of Sciences, alone being saved. The tract excited little attention, and when Lord Kelvin in 1845 found a reference to it in a memoir of Clapeyron, he only succeeded in finding a copy after three years' search. Clausius in 1870 stated that he had not up to then succeeded in finding a copy, and at the present time it is almost unprocurable

The after-Easter Lectures at the Royal Institution will begin on Tuesday, April 13, at 5.15 P.M., when Prof. J. Barcroft will deliver the first of four lectures on organs of multiple function, (I.) "The Salivary Glands." These will be followed by three lectures by Dr. G. W. C. Kaye on the acoustics of public buildings (Tyndall Lectures); and two by Sir Percy Sykes on (i.) Shah Abbas of Persia, the contemporary of Queen Elizabeth, (ii.) Chinese Turkestan and the Pamirs. Thursday afternoon lectures include three by Sir William Bragg on the imperfect crystallisation of common things; two by Mr. U. R. Evans on corrosion, tarnishing and tinting of metals; and two by Dr. J. Newton Friend on (i.) iron in antiquity, (ii.) science in antiquity. Saturday afternoon lectures include two by Dr. W. T. Calman on the shipworm, beginning on April 17; two by Dr. G. C Simpson on atmospheric electricity; and one by Prof. Alexandre Moret on "Une Revolution sociale en Egypte vers 2000 Av. J.-C." (in French). The Friday evening discourses will be resumed on April 16, when Dr. A. W. Hill will deliver a discourse on the quest for economic plants. Succeeding discourses will probably be given by Prof. R. Whiddington, Dr. W. H. Eccles, Sir Frederic Kenyon, Mr. Seton Gordon, Sir Almroth Wright, Prof. J. Garstang, Prof. J. C M'Lennan of Toronto, and others.

Summer time will come into force in Great Britain and Northern Ireland, as well as in France and Belgium, at 2 o'clock, Greenwich Mean Time, on the morning of Sunday, April 18.

Sir Henry Miers, who is retiring this year from the Vice-Chancellorship of the University of Manchester, has been elected a trustee of the British Museum in succession to the late Dr. W. Bateson. Sir Henry was a member of the staff of the British Museum in the Department of Mineralogy from 1882 until 1895.

The summer meeting of the Institution of Electrical Engineers will be held at the North-Eastern Centre, Newcastle-on-Tyne, on June 8-11. The meeting will then be in the centre of an industrial district, and numerous visits to important works in the neighbourhood, as well as to places of more general interest, have been arranged.

Mr. A. Rodger, President of the Forest Research Institute and College at Dehra Dun, will succeed Sir Peter Clutterbuck as Inspector-General of Forests when the latter goes on leave preparatory to retirement, and will combine his new duties with the presidential duties already in his charge. According to the Delhi correspondent of the *Times*, this will mean the creation of a new appointment of professor of forestry at the Research Institute and College.

THE committee of the Manchester Museum, in its report for the year 1924–25, notes that the construction of the new building provided by the late Dr. Jesse Haworth, though delayed by labour troubles, is now progressing, and it adds that if this building is to be adequately maintained, an increase in the Museum's income is imperative. One step towards that end has been taken by the committee, on the lines of the American Museum of Natural History, in enrolling all annual contributors of five shillings or more as "Members of the Manchester Museum." The committee has also widened its basis by co-opting representatives of the chief scientific societies in Manchester We cannot but feel that the Corporation of this wealthy city might increase its grant to this excellent Museum, which took the lead in the education of school-children.

THE report of the meeting in London in April 1924 of the International Commission for the Exploration of the Upper Air has recently been issued by the Meteorological Office of the Air Ministry. The report is in English but the French text of the nineteen resolutions is also given in an appendix. The most important of these resolutions are: (1) Nos. (iii.) and (iv), which register the decision of the Commission to publish in collected form the full results of the International Investigation of the Upper Air in 1923 and 1924, thus renewing an international effort which had been in abeyance since the War; (2) No. (xv.), which expresses clearly the two main purposes of international exploration of the upper air, namely, the study of the general circulation and the more detailed study of the structure of the atmosphere in different regions for different types of weather; and initiates a system of deputy presidents charged with the supervision of the investigation in different regions of the world; and (3) a resolution on p. 32 of the report affirming that barometric pressure should be expressed in millibars, and that geopotential expressed in dynamic metres should be used in place of geometric heights. Among the appendices one notes a number of memoranda presented by the Russian delegate. Until records of *ballons-sondes* for Russia and Siberia are available for the same time as those made in the rest of Europe, the solution of many of the problems connected with the stratosphere cannot be achieved. The Commission indeed affirmed this by passing a special resolution (No. viii.) "that intensive observations of *ballons-sondes* in Russia and Siberia from 3-5 stations are of great importance in the investigation of the upper atmosphere."

THE American Geophysical Union now meets annually, and the transactions of the sixth annual meeting (1925) have been issued as a *Bulletin of the National Research Council*, vol. 10, part 3, No. 53, July 1925. The major part of the bulletin is, however, devoted to abstracts of reports and papers, covering a very wide field. W. J. Humphreys reports that a rocket is being developed with the aid of which it is hoped to obtain determinations of the temperature of the upper air at various heights, and also samples of gas from these heights, for chemical analysis; direct information on both these disputed questions is much to be hoped for. The bulletin also includes a series of reports, by the American delegates, of the meetings at Madrid (1924) of the International Geodetic and Geophysical Union and its various sections. The official report of the Madrid meeting, in October 1924, of the Section of Terrestrial Magnetism and Electricity of the International Geodetic and Geophysical Union, has been issued as Bulletin No. 5 of the Section's publications. It supersedes an earlier report issued in December 1924. The contents are too varied to be detailed here, but, besides collecting opinions on many important points of organisation and observation important for the progress of the science, the bulletin affords a valuable medium for publishing reports at regular intervals of work proposed or accomplished in the different countries. The resolutions passed at the meeting, urging the necessity of establishing more magnetic observatories in high latitudes, or improving the equipment of existing observatories, have already borne fruit in one or two important cases.

WITH reference to the article on the Report of the Coal Commission which appeared in NATURE of March 20, p. 405, and to the statement therein that concealed coal could only be discovered as the result of the labours of the Geological Survey, Messrs. S. and J. Bailey, Princes Chambers, 6 Corporation Street, Birmingham, write to point out that the knowledge of the existence of much of this coal has been derived from boreholes put down by individuals at their own expense, which has often been very heavy, and in many cases has brought them in no return. The knowledge of geological structure thus obtained has often been of value to the Geological Survey. These statements are perfectly correct, but it is obvious that had there never been a Geological Survey of Great Britain, individuals would have had little or no incentive for boring and would not have known where to bore. It is precisely because the labours of geologists have in the first instance made clear the structure of the hidden portions of the earth's crust in Great Britain that boring for a concealed coalfield was rendered conceivable, let alone feasible.

THE Chemical Society of Japan has commenced the issue of a monthly Bulletin, of which we have received No. 1, vol. 1, January 1926 This development has been made possible by the presentation to the Society of a gift of money made to Prof. Ikeda to celebrate his sixtieth birthday. The publication contains short chemical papers and abstracts.

FOUR more sets of charming coloured illustrations on postcards, each set containing six cards with descriptive folder, have been issued by the Royal

Botanic Gardens, Kew (1*s.* per set). The set with rhododendrons and azaleas are very seasonable, as also two delightful series of illustrations of hardy trees and shrubs; the coloured reproduction of Japanese cherries flowering at Kew is particularly successful, but all these are extremely effective. The fourth set deals with stove and greenhouse plants.

Applications are invited for the following appointments, on or before the dates mentioned:—A biochemist for the study of the nitrogen compounds in barley and their relation to malting—The Secretary, Institute of Brewing, Brewers' Hall, Addle Street, E.C.2 (April 14). A director of experiments at the Experimental Station of the Chemical Warfare Research Department, Porton—The Chief Superintendent, Chemical Warfare Research Department, 14 Grosvenor Gardens, S.W.1 (May 1). An investigator in the Metallurgical Department of the Royal Aircraft Establishment for work on the electro-deposition of metals—The Superintendent, R.A.E., South Farnborough, Hants (quoting A. 92). An analyst under the Air Ministry for duty in Irak—The Secretary, Air Ministry (W.B. 5), Kingsway, W.C.2.

Our Astronomical Column.

Two Fireballs.—Mr. W. F. Denning writes: "On Saturday, March 20, at 6.45 P.M., when twilight was still strong and but few stars visible, a fine meteor passed from E. to W. over the south of England. It was observed by many persons, for the weather was generally clear and the flight of the object extended over about 290 miles. Reports of its appearance have come from Bampton near Oxford, Neath (Glam.), Bristol, Dartmoor, Stratton, Fowey (Cornwall), and Watford (Herts). The descriptions are not in good agreement, but they indicate a radiant point near the E.N.E. horizon. The luminous path of the object apparently extended from Kent to a region of the sea about 35 miles N. of Land's End. The height is not exactly determinable, but appears to have been lower than usual. The meteor traversed its lengthy course at a velocity of about 29 miles per second

"On Sunday, March 21, at 8.13 P.M., a very large meteor was noticed from Bristol and other places in the west of England. It was a ball of fire which moved slowly amongst the stars of Taurus and Orion. At the end point it crumbled into pieces and died away amid thin white clouds in the S.W. sky. The radiant point was at 12° + 40° in Andromeda, and its height 65 to 29 miles; path, 90 miles; velocity, 23 miles per second. This meteor appears to have been noticed by very few persons who have troubled to describe its appearance."

Comets.—There are at last some definite post-perihelion observations of Ensor's comet; they were obtained at Bergedorf observatory by A. Schwassmann and J. Stobbe They gave exposures of 2½ hours with the Lippmann astrograph, and obtained images showing a tail half a degree long in position angle 250°, which is nearly at right angles to the line from sun to comet. The tail was forked at 20′ from what was taken to be the head, but as there was no trace of a nucleus it is difficult to know what point to select for measurement. The positions they give are:

	U.T.	R.A.	N Decl.	Obs minus Tab.	Mag.
March 16d	$1^h\ 12^m$	$21^h\ 47{\cdot}9^m$	49° 6′	$+0{\cdot}2^m$	−3′	12
20	19 5	22 23 0	59 20	+0 4	−3	13

The tail was fan-shaped, its angular opening being 10°. The rapid decline in light after perihelion was quite unexpected.

Comets Borrelly, Brooks, Tuttle, Orkisz, and Van Biesbroeck have also been photographed recently at Bergedorf observatory, which makes a speciality of observing faint comets. Comets Borrelly and Brooks have now been under observation for six months, so there is ample material for improving their orbits. Van Biesbroeck's comet continues to be an easy object though nearly six months from perihelion.

The Eclipse of Odysseus.—Herr C. Schoch has written further about this eclipse, noting the corroborative facts that Homer's narrative states that the day in question was the day of new moon, and that the time of the darkness was somewhere in the neighbourhood of noon, agreeing with calculation, which gives $11^h\ 41^m$ A.M. local time. The prophet's words, "The sun is lost from the heaven, and evil darkness has come," certainly accord well with totality. Moreover, his tables, which were based on many ancient eclipses and occultations, place the northern part of Ithaca inside the track of totality. There was no other totality at Ithaca within 200 years.

Herr Schoch agrees with Dr. Fotheringham in the value used for the sun's acceleration, 2·64″ per century, but his other data are not quite the same; his centennial motion of the moon is 1″ greater than Fotheringham's. He claims that his values represent the occultations of the Almagest considerably better than Fotheringham's. He supposes that the Odyssey was written three or four centuries after the events described, but considers that the eclipse results make it probable that some trustworthy traditions of those events had come down.

A Remote Stellar System.—A study of that most interesting object N.G.C. 6822 is given by Hubble in the *Astrophysical Journal*, vol 62, p. 409. This system is a very faint cluster, closely resembling in many ways the Magellanic Clouds, both in its constituent objects as well as in general appearance, though of course it is apparently much fainter and smaller than those Clouds. Throughout the two seasons of 1923 and 1924 it was carefully observed by the author, who has obtained some fifty negatives, as well as several spectrograms, with the great reflectors of the Mount Wilson Observatory. He has found fifteen variable stars in the cluster, eleven of which are Cepheids, and five diffuse nebulæ similar to those found in other systems. The period-luminosity law for the Cepheid variables is well shown, and a comparison with Shapley's curve indicates a distance for the cluster of 214,000 parsecs (about 700,000 light-years). This enormous distance shows that the cluster must lie far beyond the limits of the galactic system; but it is corroborated to some extent by a comparison of the cluster with the Magellanic Clouds, as regards angular dimensions, luminosities of the nebulæ and of the brightest stars. Shapley had previously made such comparison, and judged the distance of the cluster to be of the order of 1,000,000 light-years. The brightest stars present appear to be of absolute magnitude about −5·9, which is in satisfactory accordance with other isolated systems such as our own local cluster and the Magellanic Clouds.

Research Items.

Archæology in Kenya Colony.—In the January number of the *Journal of the East Africa and Uganda Natural Historical Society*, Mr. G. W. B. Huntingford points out that while the antiquities of Kenya Colony provide a considerable amount of material for investigation, although it is confined to certain areas, very little attention has been paid to local archæology. The greater number of the antiquities occur in the districts of Uasin-Gishu and Nandi, with, it is believed, some in the Tanganyika territory. There are several classes of these antiquities, of which the more important are: (*a*) enclosures of stone or earth with double or single walls confined to Uasin-Gishu and not occurring in Nandi; (*b*) hut-circles occurring throughout the Eldoret area and with still more frequency in Nandi; and (*c*) pit-villages, groups of hut-circles usually earthen, some of which are even double or treble. In addition there are artificial mounds—at least two have been observed—a menhir on the summit of a hill on the western Nandi escarpment, and remains of 'roads' and irrigation canals and rows or low ridges which suggest graves. A number of 'finds' include pottery differing in character from the Nandi pottery, and a number of stone implements of various types. As regards the builders of the ruins, in the absence of excavation, no very convincing suggestion can be made, although it is clear that they were the predecessors of the present inhabitants of the area and possibly came from the north. The Sirikwa branch of the Uasin-Gishu Masai have been suggested, though certain considerations militate against this and point to these people having found the circles built when they came, while the Keyu (Elgeyo) tradition says the builders were a 'red' race, which may indicate a people of Libyan origin. There appears to be no connexion with the Zimbabwe culture, though the ruins may represent the early work of the Zimbabwe race.

Archæological Investigations at Chichen Itza, Yucatan.—Dr Sylvanus G. Morley's report on Middle American archæological research in Year Book 24 of the Carnegie Institution, Washington, covers the operations of the year 1924, when the activities of the Institution were concentrated at Chichen Itza. The most extensive piece of work undertaken was the complete clearance of the Temple of the Warriors and its partial repair. This work was under the care of Mr. R. H. Morris, who furnishes a detailed report. This building, it now appears, was one of the most important in the whole city. It is second only to the Castello in size and exceeds it in wealth of sculptured decoration. The pyramid supporting the temple covers two-thirds of an acre and rises in four terraces or steps to a height of 37 feet above the paved level of the Group of the Thousand Columns. The three lower terraces have their cornices elaborately sculptured with men, eagles, jaguars, and another as yet unidentified animal with a woolly covering. These were originally painted in brilliant colours. The interior and exterior walls of the temple were also once brilliantly painted, but the collapse of the roof has wrought irreparable damage to the frescoes. Originally there were twenty-two painted and sculptured columns, of which two—feathered serpents—stood in the doorway. Against the back wall was a sculptured and painted altar supported by nineteen painted Atlantean figures. During the repair of the Astronomical Tower, which was undertaken to preserve from shifting the passage ways formerly serving as astronomical lines of sight, a hieroglyphic band was discovered. This gives a date now deciphered as 3 Imix 9 Yax, Tun 1, which is interpreted as A.D. 1280. Six lintels discovered, four at Chichen Itza and two from Yula, apparently coincide in their day of dedication—a Tun 13 ending on a day 1 Ahau—for which a probable date is A.D. 1155.

Climate and Plant Distribution.—In a lecture delivered before the Royal Geographical Society on February 15, Dr. E. J. Salisbury discussed very fully the relation between the geographical distribution of plants and climatic factors. Although the effect of the various climatic factors upon plant growth is primarily one for investigation by the physiologist, yet the application of the results of these investigations must continue to remain the province of the ecologist or plant geographer, whose particular outlook must be much more influenced by the conception of competition as a factor of vital importance. Climate may delimit three zones in the distribution of a given plant, namely: a zone in which both abundant vegetative growth and reproduction are possible; a second zone, in which normal vegetative growth ensues but reproduction is possible only in exceptional seasons; a last zone, in which the plant may be cultivated but will not reproduce. To be of real use, plant distribution maps should, therefore, also indicate the relative abundance in different areas of the species under consideration. Dr. Salisbury also pleads for detailed maps showing the actual rainfall not corrected to mean sea-level, and for maps showing the seasonal distribution of rainfall.

Insect Pests in American Agriculture.—The report for 1925 of the U.S. Bureau of Entomology, by Dr. L. O. Howard, the chief of that organisation, has recently come to hand. It forms a record of an enormous range of activities distributed over the whole of the United States. While the progress achieved in the control of the cotton boll weevil and gipsy moth, for example, is encouraging, there are certain other major pests that seem to defy all efforts to restrain them within bounds. The European corn borer is reported to have added nearly 9000 square miles to its area of infested territory during the year. It is hoped that the enactment of compulsory legislation providing for the cleaning up of infested fields will facilitate the repression of this pest. The discovery of the alfalfa weevil in eastern Wyoming marks the entry of that insect into the extensive alfalfa region of the Mississippi basin. The Mexican bean beetle is also continuing to spread rapidly in a northern direction, it having reached the shores of Lake Erie and extended its range in other States. The report is a striking testimony to the severity of the warfare between man and insects, and how the resources of an army of investigators are being employed to attack big problems from all points of view.

Placentation in Lizards.—Prof. Harrison and Miss Weekes (*Proc. Linn. Soc., N.S.W.*, vol. 1, pt. 4, 1925) give a preliminary account of their discovery of a true placenta in an Australian lizard, *Lygosoma entrecasteauxi*. Both omphaloplacenta and allantoplacenta are present. The former is in a state of regression but shows evidence of having been more actively functional at an earlier stage. The allantoplacenta comprises a uterine part, of vascular villous ridges with modified epithelium, and a fœtal part, with greatly modified chorionic ectoderm and a complex allantochorion. True placentation has already been recorded in other lizards, and the authors suggest that the occurrence of this condition in two not very closely allied genera such as Lygosoma in Australia and Chalcides in Europe indicates that the allantoplacenta is a functional adaptation which may have arisen independently many times in evolution, and upon the mere occurrence of which phylogenetic statements cannot justifiably be based. A consideration of reptilian placentation as a whole leads the authors to suggest three stages of placentation, chorioplacenta, omphaloplacenta, and allantoplacenta, arising in that serial order both in ontogeny and phylogeny.

A Fossil Branchiopod.—Mr D. J. Scourfield publishes in the *Philosophical Transactions of the Royal Society*, B, 415, 1926, an account of an extremely interesting branchiopod crustacean from the Rhynie chert bed of the Old Red Sandstone. The species, which he names *Lepidocaris rhyniensis*, is minute, not exceeding 3 mm. in length, and probably lived in water which was hot and strongly charged with silica, by which the specimens have been beautifully preserved. It has no carapace, and in many features resembles the Anostraca, but differs from them in certain important respects. On this account a new order, the Hipostraca, is created. There are apparently no paired eyes. The antennules are three jointed and the antennæ biramous swimming organs. The mouth parts resemble those of the Anostraca, save that to the maxillules (probably) there is attached, in the male, a large clasping organ. The first three pairs of trunk limbs are phyllopodia, resembling those of the Anostraca, but having the first endite replaced by two, of which the proximal resembles the gnathobase of the Conchostraca. The remainder of the trunk limbs are of a peculiar biramous type. Curious movable scales lie above the origin of the trunk limbs. The last three segments are limbless and are succeeded by a long telson which retains the primary furca of the larva together with the secondary furca.

Fossil Footprints from the Grand Canyon.—An account has recently been published by Dr. Gilmore (*Smithsonian Miscellaneous Reports*, vol. 77, No. 9) of fossil footprints from the Grand Canyon These occur in the Coconino sandstone of Permian age, and the 'fauna' is represented by eight genera and ten species of vertebrates and two of invertebrates. No other trace of the animals that made these footprints has as yet been discovered, and for the majority of them no attempt is made to connect them with any actual animals known from elsewhere. In two cases, however, the impressions suggest forms strongly suggestive of, in one case the light lizard-like Aræoscelis, and in the other the heavier Stegocephalian Cacops. In the absence of other criteria, these tracks have some value in the geological correlation of these deposits with similar track-bearing deposits elsewhere. Dr. Gilmore is returning to the Grand Canyon to continue his investigations.

Survey Work in the United States.—In his annual report for 1924–25, the Director of the United States Coast and Geodetic Survey records a great increase in the amount of hydrographical work accomplished, owing largely to the acquisition of several large modern and well-equipped vessels. In Alaskan waters, surveys have made great progress, both in the west and on the south-east coast. Other important surveys were made on the Oregon and Californian coasts, and revision work has been done on the Georgia and Florida coasts. The survey of the Virgin Island waters is nearly completed, and good progress has been made in the Hawaiian and Philippine coastal waters. Of the geodetic work of the survey, probably the most important was that carried out along the boundary between Canada and the United States to the west of Lake Superior, but a great deal of other work was successfully undertaken. The report is fully illustrated with large-scale maps showing the progress of all surveys.

Polar Form of Ethylene Linkage.—Attempts to determine experimentally whether compounds containing the ethylene linkage exist in a polar form have been made by a quantitative study of the reaction with the Grignard reagent. The experiments by H. Gilman and J. M. Peterson are fully described in the *Journal of the American Chemical Society* for February. Under the conditions of the experiments, no active or polar forms appear to exist, or the active forms are present only in extremely small concentrations or are not sufficiently active to react with the Grignard reagent.

Melting Points of Calcium, Barium, and Strontium Oxides.—Some trustworthy values for the melting points of barium, calcium, and strontium oxides are given in the *Journal of the American Chemical Society* for February by E. E. Schumacher. Samples from several different sources were heated electrically in a tungsten boat supported on molybdenum rods in pure hydrogen at 0·2 atmosphere pressure. A carefully standardised optical pyrometer was employed to read the temperatures. The results are: calcium oxide 2576° C., barium oxide 1923° C., and strontium oxide 2430° C.

Eka-Iodine and Eka-Cæsium.—The possibility of the 'missing' elements of atomic numbers 85 and 87, eka-iodine and eka-cæsium respectively, occurring in a subsidiary disintegration series of one of the radioactive elements, is discussed in an interesting article by Prof. O Hahn in *Die Naturwissenschaften* for February 26 The nature of the surrounding elements makes this very probable, although it is pointed out that since eka-iodine and eka-cæsium have odd atomic numbers, one would expect to find only very small quantities as compared with the proximate radioactive elements of even atomic numbers. Attempts to isolate an active cæsium from a highly active mesothorium preparation containing radium are described, but the results obtained were completely negative.

Electric Salt Bath Furnaces.—The Allgemeine Elektricitätsgesellschaft of Berlin publishes every month a journal in English called *A.E.G. Progress*, of interest to engineers. The January number discusses such subjects as the life and operating trustworthiness of turbo-generators, self-regulating dynamos, wind-electric installations, benzol locomotives, etc. We were particularly interested by an article on electric salt bath furnaces. In the A.E.G. hardening furnace, a bath of molten salt is connected across the secondary of a transformer. The bath itself acts as the resistance and secures a uniform distribution of heat. The furnace is used for annealing, hardening, tempering and surface hardening (carbonising) For hardening tools of high-speed steel it generates temperatures up to 1300° C. The regulation of temperature is done by simply altering the voltage applied to the transformer. A protective hood placed over the furnace protects the operator from the heat radiated. Three-phase power is used to operate it Special mixtures of salts are generally used. For hardening high-speed steel the best salt to use is barium chloride, but for carbon steel it is better to use a mixture of barium and potassium chloride. A claim is made that an important saving is effected by the improved quality of the work and the certainty of the action of the furnace In a South African mine, the plant employed is capable of dealing with 6000 drills in eight hours at a cost of about two shillings per 100 drills. Asbestos gloves and coloured glasses are used by the operators.

Santal Medicine.[1]

THE Santals are one of numerous aboriginal tribes inhabiting those hilly tracts of western Bengal that extend southwards from the Ganges into Chutia Nagpur They are—or were—distinguished for their bravery, independence, and love of sport It was of the Santals that an English magistrate, coming among them with an official experience limited to the low-lying eastern districts of Bengal, complained that they confused him by their obstinate adhesion to the simple truth, or, as his Bengali clerk is said to have expressed it, by their ignorance of the value of a lie. More than other untutored races do Santals live in dread and constant appeasement of malignant spirits, or *bongas*. So much do these *bongas* exclude the supreme but impassive good spirit from men's minds that the earliest European missionaries, seeking among the people for some native concept of the supernatural upon which to ingraft the theology and message of Christianity, are said to have based their first unhappy attempts upon a misconception of the nature of a *bonga*.

Santal medicine, like that of the vast mass of humankind, consists of superstition tinctured with *materia medica*; but from the memoir under review, one gathers that among the Santals the superstitious element, though much preponderant, is strangely logical. The supreme excellent spirit, Cando, desires that all Santals shall live to a good old age. He may, though slow to anger, visit the whole congregation with an overwhelming punishment such as famine, but the idea of slitting the individual thread by disease is not a part of his plan Sickness must needs occur during the allotted span; but Cando has provided a sufficiency of herbs of powerful grace, which restore health. This being the ordained plan, it is useless to try to get it changed by individual supplications. For the given disease the given remedy is already provided in Nature: it may be a household remedy known to all men, or it may be known only to persons who have acquired an extensive knowledge of diseases and their appropriate treatments. The author states that there are among the Santals persons professing such knowledge, who treat the sick solely and simply under Cando's good providence, without invoking supernatural aid. Such persons he calls 'medicine men'; but if only they had received—as they have not—a professional training, they would come nearer our idea of an orthodox physician.

The true signification of 'medicine man' belongs rather to the *ojha*, a more pretentious person, who, while professing a knowledge of diseases and of natural remedies, professes also to have acquired, by special training and formal initiation, a knowledge of the supernatural which explains why the sick man does not recover, or recovers only to relapse. Serious menacing disease is due mainly to *bongas* and ancillary witches, and can be treated only by the *ojha* with perhaps the co-operation of the *ján* or witch-finder. The *bongas* can only do damage; they have neither the will nor the power to heal. They act not directly, but through human errors and through ubiquitous *tejos*, which, like microbes, exist in great numbers in the body—*e g.* scabies, ringworm, leprosy, rabies, etc., are due to the activity of *tejos* The witches also act indirectly, by secretly obstructing the efforts of the *ojha* to discover and appease the appropriate *bonga*.

The *ojha* is on familiar terms with the *bongas*. If by proper divinations, incantations (*muntars*), and sacrificial vows (*sakets*), he can get in touch with the responsible *bonga*, he may be able to appease it and can then apply his pharmacology. His attempts at communication with the *bonga* may, however, be obstructed or diverted by a witch, and then the assistance of a *ján* may be necessary. Witches, of course, are not treated by propitiatory methods—*tout au contraire*

It is notorious that the beliefs of most of the aboriginal races of India have been modified—sometimes absorbed—by the circumambient insinuating Hinduism, and the Santal theory of disease is a good example of the process. As the author points out, the *ojha* with his *muntars* (Hind. *mantra*) and *sakets* (Hind *sankt*), and the *ján* are of Hindu origin—their names bewray them. Among the *bongas*, too, there is a special contingent with Hindi names The conclusion therefore seems obvious—although the author makes no explicit statements—that the remaining and more rational parts of the theory are indigenous, and that the Santals, with their characteristic commonsense, have made a remarkably sagacious setting of the heavy exotic superstitions.

This interesting memoir in this first instalment deals in minute detail with all the paraphernalia of superstition A second instalment, treating of *materia medica* and medical treatment, is stated to be in the press.

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[1] *Memoirs of the Asiatic Society of Bengal*, vol. 10, No. 1. "Studies in Santal Medicine and connected Folklore." By the Rev. P. O. Bodding. Part I The Santals and Disease. Pp. vii+132. (Calcutta.) Rs. 5.1.

Egyptian Fisheries.[1]

NEARLY all the fisheries of Egypt lie within the territorial boundaries and are State owned. In 1924 they brought in to the Government the substantial income of some 83,000*l*.

There are three main sources from which the fish supply is drawn: (1) The Nile and inland waters, including basins and irrigation canals; (2) the Mediterranean and, to a small extent, the Red Sea; and (3) the Delta lakes. Of these three fisheries, that of the Delta lakes is by far the most important, yielding a yearly catch equal to two-thirds of the total fisheries. In the Mediterranean, Egypt possesses, in addition, very fine sponge beds within her territorial waters along the north coast of Africa, west of Alexandria.

Little information of scientific interest about the fisheries was available to the public up to 1919, except for the interesting chapter on nets and gear in use on the lakes and inland waters by Loat in Boulenger's "Fishes of the Nile." In 1919, however, the Coastguards and Fisheries Service, under the disciplinary control of which the fisheries now lie, secured the services of a scientific and technical assistant, Mr. G. W. Paget. From that date we received annually reports of great interest In April 1924 the Government closed down the Fisheries Research Section.

Between these dates the mere economic value of such an office became apparent to any one reading the reports. Of outstanding interest was a large stocking experiment that has proved an unbounded success. Of the four Delta lakes—Menzaleh, Brullos, Edku, and Maryût—the first three are either permanently, or temporarily during the year, connected to the sea by narrow straits. This allows of the population of these waters by immense numbers of grey mullet, chiefly *Mugil cephalus* and *M. capito*,

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[1] Report on the Fisheries of Egypt for the Year 1924. By Kaimakam G. Jenkins Bey. Coastguards and Fisheries Service. Ministry of Finance, Egypt. (Government Press, Cairo.) P.T. 5.

These fish, which form a very large percentage of the lake catches, migrate to the sea from the lakes to spawn. Where exactly the eggs are laid is not known, none having yet been certainly identified. As a result of the spawning, countless fry, under an inch in length, make their way back through the straits to the lakes, there to renew the stock, being attracted thither by the outflow of comparatively fresh water into the sea.

Lake Maryût, however, is at no time directly connected with the sea, the water-level being kept down by the action of immense pumps. The mullet fry are attracted by the outflow of fresh water flowing down the canal from the pumps into the sea, they swim up this canal, but their way into the lake is barred by the pumping-station. Consequently, the mullet fishery in this lake was negligible up to 1920 In that year Paget inaugurated stocking operations, whereby these fry were captured at the pumps and taken in a specially designed transport boat far out into the lake, where they were released. The following figures speak for the success of the operation. The number of fry introduced varies from year to year, but is in the neighbourhood of 30 millions. The actual lake-side weight of grey mullet caught rose from practically nil in 1920 to 223 tons with a lake-side value of E17,500*l*. in 1923, and to 406 tons in 1924, and is still rising. The actual cost of transport of the fry remains at about 350*l*. per annum. As a direct result of this experiment, Paget was further enabled to study accurately the rate of growth, under natural conditions, of the fish through three years, and to correlate growth with scale markings, with the advantage of knowing the size at which they were put into the lake The closing of the Research Office prevented this interesting problem from being carried through the later years of the fish's life

It is at any rate gratifying to note in the 1924 report, compiled by Kaimakam Jenkins Bey of the administrative staff, that attempts are being made to continue stocking the lake and also that other schemes of a somewhat similar nature, designed to improve the fisheries of the lakes and inland waters generally, that Paget had planned, are now being put in action. Amongst these is a method of driving, by means of fine-meshed nets, thousands of young fish into the main waters of the Nile from flooded areas that dry up in the heat of the summer, thus causing much waste of fish life.

A further source of valuable information to the Government was a survey of the sponge beds along the north coast of Africa, made in 1919 These beds, up to 1915, had been exploited by nomadic Greeks, who took their catches home with them From that date until 1920 the fishery lapsed on account of the War. The 1919 survey provided a basis for determining to what extent the beds will bear fishing without producing effects that may be harmful to the crops of future years. The fishery is now run on an economically sound basis and is put up to auction each season by the Government, the fishing fleet being licensed and their catches inspected at regular intervals.

It is surely false economy for a Government to dispense with an office, in no wise costly, that renders such signal service. It is, however, perhaps a promise of better things in the future to read the following passage in a covering letter to the 1924 report:

"For motives of economy the Fisheries Research Section was closed down in April 1924 and the service of the Staff dispensed with, consequently no improvement in the conditions of the industry can be expected in the future except through natural causes until such time as the situation allows for the re-establishment of the Research Section, to study local conditions, to make scientific observations and to conduct experiments with a view to increasing the fish supply and to recommend methods for preventing the destruction of immature fish."

F. S. R.

Peat in the British Isles.

A PAPER not without importance in its application to one aspect of afforestation work in Great Britain and Ireland appears in the *Empire Forestry Journal* (vol. 4, No. 2, 1925). This paper bears the title "Types of Peat and their Connexion with Afforestation," and is by Mr. A C. Forbes, Director of Forestry, Irish Free State. The problem of afforesting peat lands has been the subject of experiment for a considerable period of years in various parts of Europe, and in the British Isles two notable examples exist. The opinions of experts in this branch, based on experimental work, can scarcely be said to have been unanimous.

Mr. Forbes' paper is of value on one count, since he directs attention to the fact that the term 'peat' as used in the past has resulted in considerable confusion, and as a consequence the values of experiments undertaken have become either misleading or altogether useless for other regions or countries. The author roughly classifies what he terms 'peats proper' into five classes: (1) Turf peat, (2) heath peat, (3) mountain peat, (4) sphagnum peat, and (5) marsh peat. He shows that, so far as the bulk of the peat areas which may be of importance for afforestation purposes in the British Isles are concerned, the mountain peat is the most important. Forbes says that the confusion arising in the past, especially in connexion with German literature, has been occasioned by endeavouring to apply experiments which have proved satisfactory in the case of marsh peat to the other types of peat of his classification. "Mountain peat," he says, "is developed under humid conditions and usually at high elevations. Owing to the climatic conditions being favourable to sphagnum development, mountain peat accumulates faster and attains a greater thickness than heath peat, and may often terminate in pure sphagnum, the lower layers of which solidify, and cut off the connexion between the soil water and the surface" Mountain peat extends down to sea-level on the west coast of Ireland and Scotland and in Somerset and Devon not much below 1500 ft. The author hazards the statement that there may be no less than 10,000,000 acres covered with peat in Great Britain and Ireland. The two examples of attempts to plant mountain peat on any scale were at Knockboy, County Galway, which was a failure, and the classic work carried out by Sir John Stirling Maxwell at Corrour, a high-lying valley on the Moor of Rannoch, which is considered to be a partial success.

The author puts forward his term of 'mountain peat' with an apology, and states that 'tundra' might be a better term, though a word seldom used in the English language. The word 'tundra,' however, is essentially applied to the great marshy and peaty wastes in North Russia and elsewhere. These by the author's own showing fall under his (5) marsh peats. The term 'tundra' would therefore be misapplied to the mountain peat.

University and Educational Intelligence.

Aberdeen.—The Senatus Academicus has appointed Dr. J. L. McIntyre, lecturer on comparative psychology, a member of the Faculty of Arts.

At the Spring Graduation the honorary degree of LL.D. was conferred on Dr. R. W. Reid, emeritus professor of anatomy in the University. The following doctorates were conferred: D.Sc. on Mr. J. M. Henderson for a thesis on "The Influence of Ultra-Violet Light on the Mineral Metabolism of Growth and Lactation"; Ph.D on Mr. W. M. Dickie for a thesis entitled "The Scientific Method and Achievement of Aristotle and Bacon"; and on Mr. F. C. Kelly for a thesis entitled "The Role of Iodine in Nutrition."

The Vice-Chancellor announced bequests amounting to about 25,000*l*., bringing the total addition to the endowments of the University since the War to more than 200,000*l*.

Edinburgh.—Prof. P. S. Lelean has taken up duty as professor of public health.

Principal Ernest Shearer, of the Edinburgh and East of Scotland College of Agriculture, has been appointed professor of agriculture in the University in succession to Prof. J. A S Watson, now of Oxford. This appointment, which is the outcome of negotiations between the University and the College authorities, will lead to a more intimate relationship between the two Departments.

London.—Prof. L Dudley Stamp has been appointed as from August 1 to the Sir Ernest Cassel readership in economic geography tenable at the London School of Economics. During the latter part of the time Prof. Dudley Stamp was on war service, he carried out extensive research work on the ancient geography of north-west Europe, for which he was awarded the Gosselet Medal and Diploma by the Société des Sciences (University of Lille). From 1921 until 1922 he was geological adviser to oil companies in Burma, and since 1923 he has been professor of geography and geology in the University of Rangoon. His published work includes "An Introduction to Stratigraphy" (1923) and numerous papers in the geological periodicals.

Mr. R. B. Forrester has been appointed as from August 1 to the Sir Ernest Cassel readership in foreign trade tenable at the London School of Economics. Mr. Forrester was formerly a lecturer in commerce at the School. In 1925 he published a Report on "Large Scale Co-operative Marketing in the U.S.A." (Ministry of Agriculture Economic Reports, No. 4). He is recorder to Section F (Economics and Statistics) of the British Association.

It has been resolved to institute an Academic Diploma in Anthropology.

Applications are invited for two Ramsay Memorial Fellowships for chemical research—one for candidates educated in Glasgow—each of the annual value of 250*l*., plus a possible further sum of not more than 50*l*. a year for expenses. The tenure of the fellowships is normally two years, but an extension to a third year is permissible. The latest date for the receipt of applications, which should be sent to the Secretary of the Ramsay Memorial Fellowships Trust, University College, Gower Street, W.C.1, is June 5.

Applications are invited by the Royal College of Physicians of Edinburgh for the Dr. Jessie Macgregor prize in medical science, value 63*l*. and open to medical women who are graduates in medicine of the University of Edinburgh, or who have taken the triple qualification, and who, before becoming qualified, have studied medicine for at least one year in Edinburgh. The latest date for the receipt of applications, by the Convener of Trustees, the Royal College of Physicians, Edinburgh, is June 30.

The Rose Research Fellowship in lymphadenoma, at St. Bartholomew's Hospital, the annual value of which is 600*l*., plus expenses, will shortly be awarded. The research will be carried out at the Hospital under the direction of the professor of pathology, and the fellowship may be tenable, under annual re-election, for a period of four years Further information may be obtained personally from the professor of pathology, St. Bartholomew's Hospital, London, E.C.1, to whom applications should be sent by April 21.

Secondary education in the United States is developing along lines which point to its extension both upwards and downwards by undertaking, on one hand, the first two years' work of the hitherto normal four-years' college curriculum and, on the other hand, the seventh and eighth years' work of the elementary schools. California led the way in what is known as the 'junior college' movement, and has been followed by Illinois, Michigan, Minnesota, Missouri, Texas, and other States. Owing partly to these developments, but still more to the remarkable increase during the past five and twenty years in the number of their pupils (from 9·5 to 23 per thousand of population), the problems presented by the secondary schools in the United States to-day are many and complex. To stimulate, initiate, aid, and co-ordinate their investigation, a "National Committee on Research in Secondary Education" has recently been established in close relationship with the Bureau of Education. The chairman is J. B. Edmonson, professor of secondary education of the University of Michigan, and the secretary is E. E. Windes, a member of the staff of the United States Commissioner of Education.

The Government has decided to offer the Bloomsbury site, purchased five years ago for the University of London, to the vendor, the Duke of Bedford, on the ground that "no effective scheme for the utilization of the site" has matured. The Vice-Chancellor (Prof. E. A. Gardner) has issued a memorandum, the object of which is to show "how little the University can be blamed for being either dilatory or vacillating." The Vice-Chancellor states that "the movement of King's College from its existing site in the Strand to Bloomsbury was an absolute condition of the offer." On this question, it may be said, opinion is not unanimous, and it is significant that the establishment of King's College on the site was not made a condition in the agreement between the Duke of Bedford and the Government. It is true that Mr. Fisher's offer of April 7, 1920, was accepted by the Senate on October 20, 1920, but this acceptance was subject to onerous conditions. The existence of cross-currents is also indicated by the fact that so late as October 1925 the Senate informed the Government that the question of increased accommodation at the Imperial Institute was a matter of great urgency It may be admitted, however, that if the removal of King's College was an absolute condition of the offer of the Bloomsbury site, the delay which has occurred can be readily understood. The Vice-Chancellor states at the end of his memorandum that "it is clear that the site can be effectively used for 'University and College buildings in connection with the University of London' within the much wider terms of the agreement between the Government and the Duke of Bedford. . . . If this area is now lost to education, it or more expensive land in the same neighbourhood or near by will have to be acquired again later, bit by bit, by the University or its Colleges." We may surmise that if the University in 1920 had spoken in these clear ringing tones the course of the negotiations with the Government might have taken a different turn.

Contemporary Birthdays.

April 1, 1874. The Rt. Rev. E. W. Barnes, F.R.S., Bishop of Birmingham.
April 2, 1853. Prof. P. Phillips Bedson.
April 3, 1846. Dr. B. Daydon Jackson
April 4, 1852. Prof. Arthur P. Coleman, F.R.S.
April 5, 1849. Prof. George Forbes, F.R.S.
April 5, 1865. Sir John Bretland Farmer, F.R.S.
April 6, 1864. Sir William Bate Hardy, F.R.S.
April 8, 1859. Mr George William Lamplugh, F.R.S.
April 8, 1861. Prof. J. R. Ainsworth-Davis

Dr. Barnes, Bishop of Birmingham, was educated at King Edward's Grammar School, Birmingham, and Trinity College, Cambridge Wrangler and second Smith's prizeman, he was ordained in 1902, becoming in the same year an assistant tutor at Trinity in mathematics; afterwards (1908–15) he was tutor. From 1915 until 1919 Dr. Barnes was Master of the Temple.

Dr. Bedson, emeritus professor of chemistry in Durham College of Science, was educated at Fairfield School, Manchester, at the Grammar School there, and at Owens College. He also studied at the University of Bonn.

Dr. Daydon Jackson is a Londoner. General Secretary of the Linnean Society since 1902, he is perhaps best known to botanists through his close association with the preparation and issue of the *Index Kewensis*. He is responsible for many useful works for botanical students, notably "A Guide to the Literature of Botany" (1881); and "A Glossary of Botanic Terms" (1916).

Dr. Coleman, emeritus professor of geology in the University of Toronto, was educated at the Victoria University, Cobourg, Canada, and at the University of Breslau. At the former he was (1881–90) professor of geology and natural history. He was geologist to the Bureau of Mines of Ontario, 1893–1909, accomplishing highly important work. Murchison medallist of the Geological Society of London, he has added largely to knowledge of the history of the stratified systems and of the igneous rocks of Canada. Dr. Coleman was president of Section C (Geology) of the British Association at the Sheffield meeting (1910).

Prof. George Forbes was educated at the Universities of St. Andrews and Cambridge. He is a Chevalier of the Legion of Honour of France. Sometime professor of natural philosophy in Anderson's College, Glasgow, he afterwards devoted himself to electrical projects. Prof. Forbes was electrical engineer for the first series of installations at Niagara Falls, 1891–95.

Sir John Farmer, professor of botany in the Imperial College of Science and Technology, graduated at Magdalen College, Oxford. He is a member of the Advisory Council of the Department of Scientific and Industrial Research. In 1919 he received a Royal medal from the Royal Society for his researches in the cytology and anatomy of plants.

Sir William Hardy was born at Erdington. He received his education at Framlingham College and Gonville and Caius College, Cambridge. After some years' service, he retired last year from office as one of the secretaries of the Royal Society.

Mr. Lamplugh was born at Driffield, East Yorkshire. He joined the Geological Survey of Great Britain in 1901, becoming Assistant Director, 1914–20. He is a past president of the Geological Society.

Societies and Academies.

London.

Royal Society, March 25.—**E. B. Verney**: The secretion of pituitrin in mammals, as shown by perfusion of the isolated kidney of the dog. When the head and neck of a dog are switched into perfusion-parallel with the isolated kidney, the blood picks up during its passage through the head and neck a substance or substances which inhibit the polyuria of the isolated kidney, augment the urinary chloride output percentually, or sometimes absolutely, and diminish the renal blood flow. This result is still obtained after previous exposure of the pituitary body. It does not occur as the result of perfusing the pelvis and lower limbs in parallel with the kidney. Previous removal of the pituitary body abolishes the reaction. An antidiuretic, chloride-augmenting, and vaso-constrictor principle or principles are contributed by the pituitary body to blood during its passage through the head of a dog.—**H. W. Florey** and **H. M. Carleton**: Rouget cells and their function. Capillaries in cat's mesentery have been studied by a method which enables blood-vessels to be selectively stained by intra-arterial injection of fixative and stain. Morphologically definable Rouget cells cannot be identified. *In vivo*, capillaries reacted to mechanical stimuli and particularly to the action of histamine and pituitrin. While capillaries are capable of actively expanding and contracting, their motor activities reside, not in Rouget cells, but in the endothelial elements.—**R. M. Sargent**: The relation between oxygen requirement and speed in running. A modification is described of the usual method of determining energy expenditure during running. The subject does not wear a mouthpiece, or carry a Douglas bag, and the exercise can take place under natural conditions. The results show actual energy expenditure and that involved in 'start' and in 'pull-up.' For the subject of these experiments to run 120 yards in 13 seconds necessitated an energy expenditure equivalent to an oxygen requirement of 29 litres per minute, or to 13·7 horse-power. There is extreme energy cost for rapid and vigorous exercise of short duration. An approximate means of allowing for energy utilised in 'start' and in 'pull-up' is adopted. Then the general relation between speed in running and oxygen requirement is: Oxygen requirement per 120 yards increases about as the 2·8th power of speed. Oxygen requirement per minute increases approximately as the 3·8th power of speed. The calculated optimum performances agree well with those actually recorded (or estimated) by the subject, over the range 300 yards to 2 miles.—**Seana King**: Oogenesis in *Oniscus Asellus*.—**J. L. Synge**: On the geometry of dynamics. The representation of configurations by points of multi-dimensional Riemannian space has been used hitherto to discuss certain aspects only of classical dynamical theory. In the present paper, tensor notation is used throughout, and to the advantages of this notation the novel results are due. Parallel discussions are given corresponding to two line-elements—the 'kinematical' line-element, $ds^2 = 2T dt^2 = a_{mn} dq^m dq^n$, and the 'action' line-element, $ds^2 = 2(h - V) T dt^2 = (h - V) a_{mn} dq^m dq^n$. The laws of motion are discussed, leading to a generalisation of Bonnet's theorem on particle orbits and a geometrical elucidation of the Principle of Least Curvature. A completely determinate form of the Lagrangian equations for non-holonomic systems is developed. Necessary and sufficient conditions are obtained for the admissibility of $(N - 1)$ ignorable co-ordinates in a system with N degrees of freedom. From an invariant geometrical definition of stability three special types of particular dynamical importance are selected. A new definition of steady motion is given. The system of normals to a curve, originally defined by Blaschke, plays a fundamental part.—**P. E. Shaw** and **C. S. Jex**: Tribo-electricity and friction.—**H. G. de Laszlo**: The absorption-spectra of some naphthalene derivatives in vapour and solution. The ultra-violet absorption spectra of mono-derivatives of naphthalene containing the groups CH_3, Cl, Br, OH, COOH, CN, and NH_2, were measured in vapour and in hexane solution. The β-isomer spectra are more like that of naphthalene than the α spectra. All were shifted towards the red when compared with naphthalene by an amount which is of the same order in the case of naphthalene and benzene derivatives containing the same group. The solution spectra are always shifted towards the red when compared with the vapour. This shift varies with the group, suggesting a modified "Stark effect" when the dipolar molecules are in the strong electric field of the solvent. The bands of most of the bodies examined have been ranged in simple series. These periodicities, representing the atomic oscillations, are all smaller than that of the parent body and appear again in the infra-red.—**O. Maass** and **W. H. Barnes**: Some thermal constants of solid and liquid carbon dioxide.—**R. H. Fowler** and **D. R. Hartree**: An interpretation of the spectrum of ionised oxygen (O II). The terms of the O II spectrum deduced from the observed lines by A. Fowler are correlated with theoretical terms expected on the theory of complex spectra developed by Heisenberg and Hund. The general agreement is satisfactory. No lines involving the deepest-lying terms have yet been identified, but from consideration of the O I spectrum it appears likely that the normal term of the O II spectrum is a quartet *S* term.—**G. C. Simpson**: On lightning. The conducting channel of a lightning flash originates in the region of maximum electric field and develops only in the direction of the seat of negative electricity. A negatively charged cloud can only be discharged by a discharge originating in a positively charged cloud, or in the induced positive charge on the earth's surface. A positively charged cloud may be discharged by discharges starting in the cloud and terminating either in the surrounding air or on the earth's surface. If a lightning flash is branched, the branches are always directed towards the seat of negative electricity. The application of these conclusions to 442 photographs of lightning discharges reveals the fact that the majority of lower clouds from which discharges proceed are positively charged.

Geological Society, February 19.—**J. W. Evans**: Regions of compression (Anniversary address). The characteristic structures of regions of compression—folding, thrust-faulting and slaty cleavage—are, as a rule, the result of horizontal forces ultimately to be attributed to the contraction of the earth's interior as it cools. It has been doubted whether, with the energy released by radioactive elements, the earth cools at all. The whole of that energy, however, is not converted into heat; much must be employed in effecting physical, chemical, or atomic changes in the surrounding rock. Jeffreys shows that the contraction on cooling of the crystallised rocks is more than enough to account for the folding of existing mountains. But there are many folds of ancient mountains, now worn down, which would require still more contraction. This may have occurred in the following ways: (1) the contraction of uncrystallised magma retaining the volatile constituents is greater than that of crystallised rocks; (2) the contraction on crystallisation is equal to that on a big fall of temperature; (3) contraction may take place on changes of crystal-structure, chemical composition, or even atomic nature; (4) it will result from the loss of volatile constituents; and (5) it must follow on the increase of pressure in the earth's interior due to the slowing down of its rotation. On the other hand, the extent of the crust may be locally increased in periods of tension by (1) infilling of rifts by igneous intrusions, and (2) slip-faulting; and also by hydration of rocks. Compression and folding may also result (1) from change in the earth's form on diminished rotation; (2) from change in the position of the crust relatively to (*a*) the poles and equator, (*b*) the maximum of gravitational force. In illustration of the process of folding, two examples are described: (1) the 'Hercynian,' or 'Armorican,' folding of the south-western peninsula of England and south Wales; and (2) the Wealden folding between the Thames Valley and the 'Massif Central' of France.

Physical Society, February 26.—**J. E. Calthrop**: The effects of torsion upon the thermal and electrical conductivities of aluminium, with special reference to single crystals. An attempt has been made to find the changes produced by torsion in the conductivities of single aluminium crystals, and of the annealed and hard aluminium wires from which the crystals are prepared. The hard wire gave a decrease of a few parts in a thousand in the thermal conductivity, but no change greater than one part in 1000 has been found in crystal wires. The decreases in the electrical conductivities, of the order of a few parts in 10,000, appear to be almost the same for all specimens.—**T. H. Harrison**: A study of the concurrent variations in the thermionic and photo-electric emission from platinum and tungsten with the state of the surfaces of these metals. The thermionic and photo-electric work functions for the same specimens of tungsten and platinum depend greatly on the previous heat treatment of the material. For platinum the curves showing the dependence of photo-electric sensibility on the wave-length of the irradiation are of four different types, while as regards thermionic properties the specimens can take up either a 'large-emission' or a 'small-emission' state, according to their treatment. The photo-electric work function of platinum appears to be greater than the thermionic, but no definite results were obtained for tungsten. The photo-electric curves obtained for both metals extended asymptotically towards zero emission in the direction of increasing wave-length. The irregularities in behaviour are attributed to the state of the surface of the specimens.

Royal Statistical Society, March 16.—**Major P. G. Edge**: The growth of mortality due to motor vehicles in England and Wales, 1904-23. In 1904 171 deaths caused by motor traffic were recorded in England and Wales; by 1923 this figure had grown to 2414. During the period 1904-23, while the mortality rate due to all causes had diminished by more than 11 per cent., the mortality caused by motor traffic had increased by approximately 1000 per cent. In London the figures for 1904 and 1925 were 24 and 595 respectively. The general mortality rate in London was 30 per cent. lower in 1923 than in 1904, while motor fatalities increased by more than 2000 per cent. Motor-vans are responsible for more than their share of fatal accidents. Driving licences should only be issued after a serious test of proficiency, and vehicles should be compulsorily insured. Lack of road sense and responsibility are more frequent factors of accidents among commercial vehicles than among owner-drivers.

Official Publications Received.

Dacca University Bulletins. No. 4: Eastern Humanism; an Address delivered in the University of Dacca. By Prof. Sylvain Levi. Pp. 9. (Dacca: The University; London: Oxford University Press.) 8 annas; 8d.

The Engineer Directory and Buyers' Guide, 1926. Pp. 260. (London: 33 Norfolk Street, W.C.2.)

Calendario della Basilica Pontificia del Santissimo Rosario in Valle di Pompei per l' anno 1926. Pp. 240. (Valle di Pompei.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No 59 (Botanical Section): Hypertrophied Lenticels on the Roots of Cotton Plants. By James Templeton. Pp. 8+6 plates. (Cairo: Government Publications Office.) 5 P.T.

Air Ministry. Meteorological Office, London. Southport Auxiliary Observatory (The Fernley Observatory of the Corporation of Southport). Annual Report, and Results of Meteorological Observations, for the Year 1924; with an Appendix containing particulars of the principal Periodic Terms found in Southport Rainfall by the application of Harmonic Analysis. By Joseph Baxendell. Pp. 28. (Southport: Fernley Observatory; London: Meteorological Office.)

Department of the Interior: Bureau of Education. Bulletin, 1926, No. 21: Health and Physique of School Children. By Dr. James Frederick Rogers. Pp. 16. 10 cents. Bulletin, 1926, No. 23: Statistics of Private High Schools and Academies, 1923–24. Pp. 37. 5 cents. Bulletin, 1925, No. 27: Some recent Movements in City School Systems. By W. S. Deffenbaugh. Pp. 22. 5 cents. Bulletin, 1925, No. 30: Parent-Teacher Associations at Work. By Ellen C. Lombard. Pp. 15. 5 cents. Bulletin, 1925, No. 32: Agricultural Education. By George A. Works. Pp. 11. 5 cents. School Health Studies, No. 10: Progress and Prospect in School Health Work. Pp. iv+54. 5 cents. (Washington, D.C.: Government Printing Office.)

Library of Congress. Report of the Librarian of Congress for the Fiscal Year ending June 30, 1925. Pp. xi+309+4 plates. (Washington, D.C.: Government Printing Office.)

Department of Commerce. U.S. Coast and Geodetic Survey. Serial No. 309: Triangulation in Maryland. By Hugh C. Mitchell. (Special Publication No. 114.) Pp. vi+608+28 plates. (Washington, D.C.: Government Printing Office.) 1 dollar.

Department of the Interior: U.S. Geological Survey. Forty-sixth Annual Report of the Director of the Geological Survey to the Secretary of the Interior for the Fiscal Year ended June 30, 1925. Pp. ii+91. Bulletin 777: Pre-Cambrian Rocks of Gunnison River, Colorado. By J. Fred Hunter. Pp. vi+94+15 plates. Bulletin 778: Chemistry of Deposition of Native Copper from Ascending Solutions. By Roger C. Wells. Pp. ii+71. 15 cents. (Washington, D.C.: Government Printing Office.)

Classified List of Publications of the Carnegie Institution of Washington. Pp. 220. (Washington, D.C.: Carnegie Institution.)

Smithsonian Miscellaneous Collections. Vol. 77, No. 8: The Morphology of Insect Sense Organs and the Sensory Nervous System. By R. E. Snodgrass. (Publication 2831.) Pp. 80. (Washington, D.C.: Smithsonian Institution.)

United States Department of Agriculture. Separate from Yearbook 1924, No. 918: Weather and Agriculture. By A. J. Henry, J. B. Kincer, H. C. Frankenfield and W. R. Gregg, B. B. Smith and E. N. Munns. Pp. 457-558. (Washington, D.C.: Government Printing Office.) 20 cents.

Seale-Hayne Agricultural College, Newton Abbot, Devon: Department of Plant Pathology. Second Annual Report for the Year ending September 30th, 1925. (Pamphlet No. 19.) Pp. 22. (Newton Abbot.)

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 19: Statistics of Land-Grant Colleges, Year ended June 30, 1924. By Walter J. Greenleaf. Pp. v+51. (Washington, D.C.: Government Printing Office.) 10 cents.

Proceedings of the Lake Superior Mining Institute, Twenty-fourth Annual Meeting (Marquette Range) held at Ishpeming and Sault Ste. Marie, August 13 and 14, 1925. Vol. 24. Pp. xxx+574. (Ishpeming, Mich.)

Transactions of the Geological Society of South Africa. Vol. 28, January to December 1925: Containing the Papers read during 1925. Pp. iv+178+15 plates. (Johannesburg: Geological Society of South Africa; London: Wheldon and Wesley, Ltd.) 42s.

Proceedings of the Geological Society of South Africa. Containing the Minutes of Meetings and the Discussions on Papers read during 1925. To accompany Vol. 28 of the Transactions, January–December 1925. Pp. iii+1. (Johannesburg: Geological Society of South Africa; London: Wheldon and Wesley, Ltd.)

Botanical Survey of South Africa. Memoir No 8: Researches on the Vegetation of Natal. Series 2, including Accounts of Investigations on (i) The Water Relations of some Natal Plants, with special reference to the Leaves of *Pteroxylon utile* and *Portulacaria afra*; (ii) The Water-retaining Capacity of certain Woods in relation to their Microscopic Structure; (iii) The Water Requirement and Transpiration of a common Natal Weed, *Bidens pilosa* (L.). By Dr. J. W. Bews and Dr. R. D. Aitken. Pp. 64. (Pretoria: Government Printing and Stationery Office.)

Board of Education. Report of the Departmental Committee on the University of London. (Cmd. 2612.) Pp. 76. (London: H.M. Stationery Office.) 1s. 3d. net.

Irish Agricultural Organisation Society, Ltd.: Butter Control Scheme. A Creamery Survey. By James Cullen. Pp. 31. (Dublin: Plunkett House, Merrion Square.) 1s.

Journal of the Marine Biological Association of the United Kingdom. New Series, Vol. 14, No. 1, March. Pp. 288. (Plymouth: Marine Biological Association; London: Dulau and Co., Ltd.) 7s. net.

Transactions and Proceedings of the Perthshire Society of Natural Science. Vol. 8, Part 2, 1924-25. Pp. 17-118+plates 5-17+xvii-xxviii. (Perth.)

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 55, July to December 1925. Pp. xii+199-490+20+37+plates 23-40. (London: Royal Anthropological Institute.) 15s. net.

Quarterly Journal of the Royal Meteorological Society. Vol. 52, No. 217, January. Pp. 126. (London: Edward Stanford, Ltd.) 7s. 6d.

Annual Report of the Meteorological Observatory of the Government-General of Tyôsen for the Year 1922. Pp. v+148. (Zinsen.)

Report of the Rugby School Natural History Society for the Year 1925. Pp. 54. (Rugby.)

Transactions of the Royal Society of Edinburgh. Vol. 54, Part 2, No. 8. Scottish Drumlins. By Prof. J. W. Gregory. Pp. 423-440+1 plate. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 1s. 6d.

Proceedings of the Royal Society of Edinburgh, Session 1925–1926. Vol. 46, Part 1, No. 11: The Intermittence of Electric Force. By Sir J. J. Thomson. Pp. 90-115. 2s. 6d. Vol. 46, Part 1, No 12: On the Adjustment of Sir J. J. Thomson's Theory of Light to the Classical Electromagnetic Theory. By Prof. E. T. Whittaker. Pp. 116-126. 1s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Diary of Societies.

SATURDAY, APRIL 3.

SCOTTISH JUNIOR GAS ASSOCIATION (Annual Meeting) (at Royal Technical College, Glasgow), at 7.—Prof. T. Gray: Address.

TUESDAY, APRIL 6.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—W. J. Williams: Technical Education in relation to Industry.

WEDNESDAY, APRIL 7.

INSTITUTION OF AUTOMOBILE ENGINEERS (Derby Graduates' Meeting) (at Cavendish Café, Derby), at 7.30.—A. A. Rubbra: Problems of the High-speed Optical Indicator.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—H. Droop Richmond and J. A. Eggleston: The Analysis of Acetic Anhydride.—H. Droop Richmond and E. H. England: The Analysis of Glacial Acetic Acid.—Dr. J. F. Tocher: (a) Errors of Personal Judgment in Chemical Work; (b) Results of Further Work on Variations in the Composition of Milk.—E. R. Bolton and K. A. Williams: A Test for Tung Oil.

THURSDAY, APRIL 8.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—S. Mavor: The Applications of Machinery at the Coal Face.—L. Miller: The Design of Storage-Battery Locomotives for use in Coal Mines.—R. Nelson: Electricity in Mines: A Short Survey.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Marchese De Pinedo: A 35,000 Miles Flight.

INSTITUTION OF STRUCTURAL ENGINEERS, at 7.30.—E. S. Andrews: The Production of Structural Steel Sections.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 8 St. Martin's Place, W.C.), at 8.—Dr. A. P. Laurie: The Optical Properties of Linseed Oil.

SOCIETY OF DYERS AND COLOURISTS (Bradford Junior Branch).—C. O. Clark: The Proofing of Textiles against Insect Pests by means of Eulan.

FRIDAY, APRIL 9.

ROYAL SANITARY INSTITUTE (in Town Hall, Weston-super-Mare), at 11 A.M.—The Rôle of Different Agencies in the Improvement of the Milk Supply:—Dr. W. G. Savage: The Bacteriological Laboratory.—W. S. Stevens: The Veterinary Surgeon.—H. R. Day: The Milk Inspector.—J. W. Dallas: The Agricultural Institute.—P. B. Tustin: The Large Scale Distributor and the Consumer.

DIESEL ENGINE USERS' ASSOCIATION (at Caxton Hall), at 3.30.—W. A. Tookey: Industrial Tests on Internal Combustion Engines.

ROYAL ASTRONOMICAL SOCIETY, at 5.—J. M. Reesinck: Note on the Radiation of a Pulsating Star.—S. A. Mitchell and H. L. Alden: The Photometric Scale of the Leander McCormick Observatory.—(The late) E. E. Barnard: Visual Observations of the Brightness of Nova Persei No. 2 (Anderson 1901).—S. A. Mitchell and H. L. Alden: Observations of Nova Persei (1901) made with the 26-inch Refractor of the Leander McCormick Observatory.—Dr. J. K. Fotheringham: Precession, Galactic Rotation, and Equinox Correction.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—Annual Meeting.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (Annual General Meeting) (at St. Mary's Parsonage, Manchester), at 7.—Prof. R. V. Wheeler: The Constitution of Coal.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—S. Hazzledine Warren: The Preservation of Fragile Remains.—F. H. Worsfold: An Examination of the Contents of the Brick-Earths of Tankerton Bay, Kent.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—T. H. Dimbleby: Modern Methods of Cast Iron Pipe Manufacture.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.30.—W. S. Burn: High Powered Oil Engines.

INSTITUTE OF METALS (Sheffield Section) (at Sheffield University), at 7.30.—R. T. Rolfe: Bronze.

PHILOLOGICAL SOCIETY (at University College), at 8.—English Dialect Society and Dictionary.

SATURDAY, APRIL 10.

MINING INSTITUTE OF SCOTLAND (at Glasgow).

INTERNATIONAL MEETING.

APRIL 16 TO 20.

INTERNATIONAL SOCIETY OF MEDICAL HYDROLOGY (Annual Meeting will be held in Czecho-Slovakia). (Particulars from Dr. E. P. Poulton, at 36 Devonshire Place, W.1.)

CONGRESS.

APRIL 2 TO 21.

JERUSALEM AND BEIRUT, INTERNATIONAL ARCHÆOLOGICAL CONGRESS.

SATURDAY, APRIL 10, 1926.

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British Optical Science.

THE practice of optical science is largely concerned with the provision of means for aiding vision and increasing its effectiveness. Of the human senses, vision is the one on which, above all others, scientific work directly or indirectly depends for its successful prosecution. Thus, while optics may be regarded as the handmaiden of the other branches of science, the service rendered by it is essential and fundamental. It has provided science with—if we may quote the three classical examples—the microscope, without the aid of which medical science would have made little progress; the telescope, which has enabled astronomy to explore the heavens; and the spectroscope, which has played such a predominant part in modern physics and astrophysics.

With the increasing application of science and scientific methods to industrial processes, optical science has been brought more and more into the service of industry. It has efficiently fulfilled this service by reason of the fact that it has been able to provide not only delicate and powerful means of making observations, but also means of making accurate quantitative measurements in a simple and rapid manner. The use of the spectrometer in chemistry and the chemical industry, of the refractometer in biochemistry and in the preparation of foodstuffs, of the polarimeter in the evaluation of essential oils and in the sugar industry and of the interferometer in the examination of gases and liquids, are a few examples of such applications, which are generally distinguished by simplicity of manipulation and by the rapidity with which results can be obtained.

As the study of absorption spectra has progressed, the measurement of selective absorption has become of great practical importance to the chemist, and spectrophotometers are now in regular use which enable quantitative measurements to be made, not only in the visible spectrum, but also in the infra-red and in the ultra-violet. The modern colorimeter has provided means by which the analysis and specification of colour can be recorded numerically, and thus permits of the accurate reproduction of any colour without recourse to the instrument on which the analysis was actually made. The position occupied by the microscope as an instrument of control is so thoroughly appreciated that it need scarcely be mentioned. A casual study of the many papers that have been read at the meetings of the Industrial Applications Section of the Royal Microscopical Society is sufficient to make one realise the difficulty of specifying any industry of real importance which has not materially benefited by the use of the microscope. The application also of the camera and of optical projection methods in routine testing and in specific investigations in industry has now been definitely established.

A survey of the uses to which optical instruments have been put might be indefinitely extended. Not only in industry but also in astronomy and geodesy, in medicine and biology, in aviation and navigaton, in photometry and illumination, in education and entertainment, has optical science found wide and useful scope for the application of its products. Nor has it neglected the simpler appliances on which so many of us depend for overcoming the limitations of our unaided vision and enabling us to carry out our ordinary occupations with greater comfort and consequently with greater efficiency. There has been evidence of growing interest in the care and preservation of the eyesight, whether of the child, the adolescent, or the adult, and considerable attention has been directed to a study of the eye, more especially with regard to the mechanism and processes involved in the act of seeing. Improvements have been effected in the methods and apparatus for detecting and measuring errors of curvature and refraction of the eye, and, simultaneously, investigations have been conducted which have resulted in many important improvements in the form of the lenses applied to give the necessary correction.

The advances which have been made during recent years in the development and production of new types of optical instruments have been notable and far-reaching in their effects. On a previous occasion (NATURE, Aug. 22, 1925, pp. 265-267) we referred to the predominant share taken by British workers in aiding these advances and suggested that, in the interests of the optical industry, its achievements should be made more widely known. The forthcoming Optical Convention, which is to be held during the week April 12-17, should provide an opportunity for the technical and general public to obtain a comprehensive account of the important developments that have taken place in optical science and in the optical industry in Great Britain since the last Optical Convention in 1912.

At no time in the history of British optics has progress been more rapid than during this period, and evidence of this progress in the different branches of theoretical optics, in the varieties of optical instruments, and in the various applications of optical methods, should not be lacking. British optical products are of such variety that a thoroughly organised and descriptive exhibition of them should have a high educational as well as commercial value, and should prove of interest not only to the optical expert and to those engaged in scientific work in which optics is subservient to some other branch of science, but also to that large and ever-increasing body of regular users of optical instruments of various types who are yet uninstructed in the nature, construction, or origin of the instruments they use.

The invention of optical systems and the development and perfection of new instruments, during the period under review, have been accompanied by investigations into the fundamental scientific principles on which they are based, and results of considerable value have been published. Continuous investigations have been conducted, for example, in analytical geometrical optics, in refractometry, and in colour measurement at the National Physical Laboratory, Teddington, in physical optics and instrument design at the Imperial College of Science and Technology, London, and in ophthalmological optics at the Northampton Polytechnic Institute, London. Investigations of a fundamental nature, as well as those directed towards immediately practical ends, have also been conducted at the British Scientific Instrument Research Association, at various universities and colleges, and in the laboratories of several manufacturing firms in the optical industry. The full nature and extent of these investigations will no doubt be clearly indicated during the Convention, and also their influence, on one hand, on optical production, and, on the other, on the progress of related branches of science.

Papers dealing with the results of these investigations will be of interest mainly to those engaged professionally in optics or in the application of optics to some special science. The programme also includes, however, lectures addressed more particularly to the amateur, and discourses and demonstrations of such a character as to show the position of optics in the everyday life of the individual and of the nation. Thus, if the aims and objects of the Convention are even in part attained, there should result not only a much wider appreciation of the past achievements and current enterprise of the British optical industry and those associated with it, but also an appreciation of the part played by optical science in almost every sphere of human endeavour.

Agricultural Progress in the United States.

History of Agriculture in the Northern United States, 1620–1860. By Dr. Percy Wells Bidwell and Prof. John I. Falconer. (Publication No. 358.) Pp. xii+512. (Washington: Carnegie Institution, 1925.)

FROM the time of the Pilgrim Fathers in 1620 until the Civil War and the abolition of slavery in the middle of the last century, agriculture in the northern United States developed steadily from the smallest beginnings, progress being intimately associated with increasing colonisation and extension of occupied lands westward. In the present volume the authors have most ably presented the history of American agriculture up to the time that a radical change in the economic life of the nation was brought about by the Civil War. The account is one that will appeal to the general reader of history as well as to the agricultural worker; and, notwithstanding the wealth of detail, it captures the imagination and leaves a clear and forcible picture of the progress of agricultural development in the States.

The earliest settlers on the eastern seaboard found some land already cleared and abandoned by the Indians, and further rough clearance was made by burning woods and meadows. Maize was the chief grain crop from the beginning, and the primitive method of manuring was to insert two or three fishes in each hill of corn. Multiple cropping was practised with maize, peas, and pumpkins, and wheat did well when introduced until attacks of black-stem rust, about 1860, caused spring wheat to be abandoned in favour of autumn wheat. Stock was very scarce at the beginning, the initial difficulty being shortage of forage, the native grasses not being sufficiently nutritious. The rapid spread of introduced English grasses and clovers improved matters, and islands were largely utilised for pasturage, as the common field system of agriculture precluded grazing for much of the year. The introduction of sheep was encouraged by legislation, especially in New England, and though horses were also brought in, oxen were preferred for most farm work for almost two hundred years longer. The earliest New England farms were very small, only about 13 to 38 acres, which was rather surprising considering the cheapness of land. Lack of capital was the difficulty, and this was reflected in the scarcity of livestock and food supplies and the poverty of farm tools and implements, even ploughs being missing at first, the work being done by mattocks and hoes. The first beginnings of trade in agricultural products were to relieve the food shortage, but eventually trade between the West Indies and New England was a central feature of economic life. New England supplied general agricultural necessities to specialised sugar-planting islands which could not afford time or labour for producing them. Export of horses and salted meat began about 1650, and continued until the end of the eighteenth century. Boston, Philadelphia, and New York became the chief centres for internal trade in farm products.

Various systems of land tenure and distribution were adopted by different colonies, but the fundamental economic condition behind them all was the abundance of cheap land, which made both large estates and tenancy impossible. New England adopted community settlements, and common fields survived in pastures long after tillage fields had been separately enclosed. The system in the middle colonies was that of settlement by the individual and payment by quitrents, which were practically unknown in New England.

During the eighteenth century two types of agriculture existed, that of pioneering in new settlements on the frontier, steadily advancing to the west, and that of the older agricultural communities on the seacoast. The continual grain cropping and general lack of manuring caused much land soon to become 'worn out,' and westward migration in search of more fertile areas became general. Nevertheless, the value of land in the eastern colonies rose rapidly, and land speculation became rife. As time went on the land systems put into force in the different States opened up affected the relative colonisation and, except in New York State, the settlement of back country was favoured. Emigration west was also partly influenced by a growing desire to escape from the puritanical social and ecclesiastical systems common in early settlements. The pioneers cleared land by girdling or burning, followed by two years' grain crops and then grass. The life was extremely hard, but resulted in great increase in the capital value of the holdings even when incomes were small. Lumbering, potash, and maple sugar-making were subsidiary industries in suitable districts.

About 1780 the poorness of the farming was noteworthy, rapid deterioration of land being caused by lack of rotation crops. Successive unmanured grain crops were taken until the land was exhausted, when it was allowed to become covered with grass and bushes for several years until it was considered sufficiently rested to produce more grain. This system of weed fallowing for renewal of fertility was gradually replaced by sowing down artificial meadows, as the stock increased beyond the capacity of natural pasturage. Some manures, as seaweed, gypsum, and limestone, came slowly into use after 1750, and rotations were introduced. Maize held its position as the chief grain crop, the total produce being more than all other cereals together. The association of wheat rust with the barberry was soon recognised, and legislation against the shrub was in force so early as 1726 in Connecticut.

The colonial farms, throughout the eighteenth century, were almost entirely self-contained, providing food, clothing, and housing for their occupiers; salt, molasses, rum, tea, and coffee being almost the only goods habitually bought. Farmers on the coast were often sailors or fishermen as well, and inland farmers were often artisans. The lack of a home market was the insuperable barrier to specialisation in farming and prevented progress, in inland towns especially. Export trade to Europe grew towards the close of the eighteenth century, but that to the West Indies remained the most important, $1\frac{1}{2}$ million bushels of maize being exported thereto in 1792, and more than 1 million bushels of wheat.

The first forty years of the nineteenth century marked a period of expansion and progress, as the population rapidly increased with a westward movement. The government federal land policy favoured settlement, giving liberal political privileges and freedom from tariff restrictions to new settlers. West of the Alleghanies the richer land gave better crops and pasturage, but all the early western settlements were extensive in nature, little labour and capital being expended over large areas, production being chiefly for home consumption until such time as markets were opened up. The gradual development of internal western trade with an eastern market for livestock was of great significance in American economic and political history. At the end of the eighteenth century definite interest in agricultural improvement was aroused, and the first agricultural society was founded in Philadelphia in 1785; others followed, and were pioneers in agricultural education.

In 1807 one Elkanah Watson exhibited two merino sheep at Pittsfield, Massachusetts, thus founding the cattle shows or fairs in the United States, making the direct appeal to farmers which the agricultural societies had failed to do. State aid was forthcoming, and a chair including agriculture was founded at Columbia University, while at Gardiner, Maine, the first institute for teaching farming only was opened in 1822. The Agricultural College, however, was founded considerably later, in 1857, at Michigan. During this period also many types of labour-saving machines were introduced, aiding progress still further. Wool growing on a commercial basis began to develop in a spectacular way in the eastern States, nineteen million sheep being grown in 1840, and general improvement and specialisation of livestock took place, with the introduction of special breeding stock from abroad. Throughout the colonies a gradual transition was taking place from self-sufficient economy to commercial agriculture, the chief hindrance being lack of working capital and imperfect organisation of markets. The most significant change was the decline in household industries, with the transfer of textile industries from farm-house to factory.

After 1840 a period of transformation set in, which is dealt with very fully by our authors. The development of prairie agriculture in the west, with rapid settlement and soil exploitation, the building of canals, roads, and railways, thus giving access to new markets, caused readjustment of eastern farming to meet western competition, while the advance in agricultural chemistry made possible the era of artificial fertilisers. By 1860 the increase in corn production and stock rearing had pushed steadily westwards, while hay was the leading crop in the east, where dairy farming had grown steadily in importance.

The situation at the close of the period under consideration may best be indicated by a quotation:

> "Whenever a branch of agricultural production, such as wheat, wool, or beef, proved profitable in the west and poured its supplies into the eastern market, it became necessary for the eastern farmer to find some other line of development; and, fortunately for the eastern farmer, the development of an urban population made this possible. The uncertainty in the choice of farm enterprises was stimulating to thought. It tended to make the agriculture of the period rational rather than traditional. It stimulated the development of the agricultural press and paved the way for the establishment of agricultural education."

W. E. B.

Crystals and Chemistry.

Crystalline Form and Chemical Constitution. By Dr. A. E. H. Tutton. Pp. xii+252. (London: Macmillan and Co., Ltd., 1926.) 10*s*. 6*d*. net.

Time was when the crystal was emblematic of the mysterious and the supernatural; the regularity and beauty of its outward form inspired the belief that it possessed properties which placed it on a different plane from ordinary matter. Science has discredited the superstition but has really emphasised the wonder and the mystery. That the regularity of form implied a corresponding regularity in elemental structure was early recognised, and many and varied have been the attempts to explain the nature of a crystal in terms of the properties of the chemical molecules of which it is composed. Of recent years the subject has received fresh attention chiefly because the discovery of X-rays has placed in the hands of the physicist a new tool which enables him to probe beneath the surface and actually to examine the arrangements and dispositions of the atoms or molecules in the small unit of pattern, the continued repetition of which finally results in the familiar crystal. The widespread and continually expanding applications of X-rays to the problems of crystallography have perhaps resulted in a tendency to ignore the results of previous work, and a book such as this will perhaps do something to emphasise the immense volume of results accumulated by the pure crystallographers, results which have perhaps not always had the recognition they merit.

The book contains the subject matter of a series of lectures and is, in a way, an abstract of some of the material dealt with more fully in the author's larger and well-known text-book. The title is a somewhat comprehensive one, and it is not to be expected that the whole of the field it implies can be covered in a relatively small volume. Dr. Tutton's own researches form the bulk of the material on which the deductions are based. These are, for the greater part, concerned with some remarkable isomorphous series, the alkali sulphates and selenates and the corresponding double sulphates and selenates. For the satisfactory examination of the small variations in structure of the members of such series, the author was forced to devise new and more accurate methods of measurement, and one chapter is devoted to a description of some of the elaborate and ingenious instruments designed especially for this work.

In the succeeding chapters are given the results of these investigations, results which once more demonstrate that an increase of knowledge almost always results from an increased precision of measurement. The author emphasises the fact that, although there is a very close resemblance between the various members of these series, there are differences and these differences are subject to very definite laws. For example, when potassium is replaced successively by rubidium and cæsium, all the properties of the crystal show progressive changes; rubidium is always intermediate between potassium and cæsium, no matter whether it is the dimensions or angles of the crystal unit, the refractive indices, the heat expansion, or some other property which is being measured. In the same way, it is always found that the ammonium salt resembles extremely closely that of rubidium, implying that a replacement of the rubidium atom by the NH_4 group can be effected with practically no change in the crystal properties.

In the latter half of the book various interesting problems are discussed, problems which are for the most part suggested by the researches on isomorphous series. There Dr. Tutton describes the conditions which favour the growth of crystals of one substance on the surface of another and the formation and nature of mixed crystals. Further chapters are devoted to the questions of enantiomorphism and optical activity and to that interesting phenomenon, the liquid crystal.

A brief survey is given of Federov's methods of crystal classification and description, and in directing attention to this work the author has performed a real service. To one accustomed to the usual method of crystal description, Federov's papers make difficult reading, but the signs are not wanting that there is a real physical significance in the notation and that, in many cases, the description of a crystal in the way advocated by Federov gives a valuable clue to the molecular arrangements.

Throughout the volume the author frequently refers to the results of X-ray measurements, but has made no attempt to give a full account of this work. His aim has rather been to show how it has confirmed and extended the deductions made by the older methods. This does not mean that he does not appreciate the X-ray work; in fact, in his enthusiasm for it, he is apt at times to take as an established fact what the X-ray worker intended only as a speculative suggestion.

The book is admirably produced and profusely illustrated by excellent diagrams and plates, and is completed by a bibliography of the author's researches and a detailed index. It is perhaps a pity that no references are given to the many other researches described throughout the volume.

Osteology of the Reptiles.

The Osteology of the Reptiles. By Prof. Samuel Wendell Williston. Arranged and edited by Prof. William King Gregory. Pp. xiii + 300. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1925.) 18s. 6d. net.

IN no domain of zoological science have the contributions of American naturalists been more splendid than in that of vertebrate palæontology, and in the list of pioneer workers in this domain an honoured place will always be accorded to Samuel Wendell Williston, who, born and nurtured in obscurity, had by the time of his death in 1918 won his way to recognition as the chief authority upon the extinct amphibians and reptiles. Apart from his specialist papers upon fossil vertebrates and upon modern dipterous flies, Williston was well known to the general zoologist for his excellent book on "Water Reptiles of the Past and Present," published in 1914, and during the last year of his life he was busily engaged in the preparation of a second work of a general character on "The Reptiles of the World, Recent and Fossil." The volume now under review comprises the main part of this general work, so far as it had been completed at the time of the author's death, put into shape and edited at the competent hands of Prof. W. K. Gregory.

The book is one which will be of great use to the student and teacher of osteology, while to the general zoologist it will serve the useful purpose of providing a conspectus of contemporary knowledge regarding the bony skeleton of extinct reptiles, drawn up by a master of the subject.

Perhaps the most valuable part of the book consists of the series of illustrations, nearly two hundred in number. These are for the most part line drawings by the author, embodying the latest results of palæontological research whether by himself or by others, and of admirable clarity. While these drawings take up a large part of the whole volume, they are accompanied by clear and valuable letterpress—interrupted here and there by gaps still unfilled when the author finally laid down his pen. The weakest parts of the book are to be found, as in many other palæontological works, where the author strays beyond the confines of osteology into the field of general evolutionary theory. Such old friends as "evolution is irreversible," "there has been a continuous loss of parts" (in the evolutionary history of the bones of the skull), "a race of small animals has never been evolved from a race of large animals," had better be omitted in the text-books of to-day. They are in conflict with one of the main canons of evolutionary philosophy—that its principles must be founded upon a broad basis in which are incorporated the available facts not of palæontology alone but of comparative anatomy, embryology, physiology, and field natural history as well.

In practice such statements do harm; for the student, his attention gripped in the first instance and his interest fired by such clearly and crisply enunciated 'laws,' is bound sooner or later—if he passes into territories other than those of fossil osteology—to come across facts which raise doubts in his mind as to whether there is anything in such so-called laws. He finds, for example, the facts of embryology assuring him that the early evolution of the Amniota has as one of its characteristic features the gradual increase in the size of the egg correlated with the provision of a larger and larger amount of hoarded-up food material or yolk, and that on the other hand the evolution of the modern mammal has involved a reversal of this evolutionary process—the supply of food yolk being gradually reduced and the egg reverting to a comparatively small size. He is assured again that the evolution of the modern fishes has involved the primitively symmetrical pointed tail passing through a period of gradually increasing asymmetry, but that at a later period the evolutionary history of various highly specialised modern teleosts has involved a reversion to the symmetrical pointed form of tail. He learns that in the evolutionary history of the cranial bones, reduction in number of elements by processes of fusion rather than of elimination are by no means to be ignored. He realises that although it is perfectly true that increase in size of body has been one of the principal features of animal evolution, there are yet very numerous cases where adaptation to a particular mode of life has involved great diminution of size.

However, such little aberrations, as I regard them, into unsound evolutionary philosophy must not be allowed to distract our attention from the main fact that this last book by Samuel Wendell Williston is, as regards what it purports to be—a text-book on the osteology of the reptiles—of admirable quality and great value.

J. Graham Kerr.

Enzyme Action.

Die Fermente und ihre Wirkungen. Von Prof. Dr. Carl Oppenheimer. Nebst einem Sonderkapitel: *Physikalische Chemie und Kinetik*, von Dr. Richard Kuhn. Fünfte völlig neu bearbeitete Auflage. Lief. 1-8. Pp. 1204. (Leipzig: Georg Thieme, 1925.)

PROBABLY all the important chemical actions operative in animal and vegetable systems take place through the agency of enzymes or ferments, the organised catalysts.

It is somewhat unfortunate that the difficulties attending the preparation and purification of enzymes are so great that the chemical composition of any one of a very numerous family is still unknown. Even Willstätter's preparations in a high state of purity contained both proteins and carbohydrates in variable quantities. Many attempts dating from the time of Liebig have been made to elucidate their mode of operation, and to obtain from an examination of the physical and chemical processes of enzyme action some idea of their chemical constitution and structure. The evidence in favour of the hypothesis that enzymes exert their catalytic properties by a process of adsorption, similar in some respects at least to the inorganic catalysts, appears to be complete, but the nature of the adsorption complexes is unknown. It is frequently argued that since enzyme action is even more selective in action than is the case with inorganic catalysts, the adsorbate-substrate union must be highly complex. We find the view fully expressed that enzymes may be regarded as proteins, globulin-like in character, the union to the adsorbate being effected by reactive groups which occur at definite space intervals along the complex molecule. The selective action of hydrolytic enzymes for optically active adsorbates lends support to the multipoint contact or 'key in lock' hypothesis, but, as in the case of simple inorganic hydrolysis, the effect of steric hindrance on one reactive group and on the reaction velocity is a factor which cannot be left out of consideration.

It is fully established that enzymes are very sensitive to a change in hydrogen ion concentration of their environment, supporting the view that they are amphoteric substances possessing diverse activities in their different ionic modifications. At the same time, the enzymes are colloidal in their nature and their activity is greatly dependent on the degree of dispersion, which in turn is affected by numerous factors such as alteration in the protein content of the solution which serves to support or protect the enzyme, the presence of electrolytes, alteration in temperature or intensity of incident radiation.

The fifth edition of Prof. Oppenheimer's "Die

Fermente und ihre Wirkungen" must be considered as the most authoritative work that has yet appeared on this subject. A casual glimpse of the various volumes, of which eight have now appeared, indicates that a veritable "Beilstein" of information has been collected together. A closer inspection reveals the fact that the vast mass of experimental data has been carefully assimilated and subjected to a critical examination. The alternative points of view of various investigators have been given without bias.

The book may be divided into three parts. In the first the chemical and physico-chemical characteristics of enzyme action are discussed in detail. Nearly three hundred pages of text, plentifully supplied with diagrams, experimental data, and references which appear completed up to and including the year 1924, have been written by Dr. Richard Kuhn on the physical chemistry of enzyme action, forming in itself a monograph which is not only a mine of information but also a model of condensation and clarity.

A short section is devoted to a discussion on the biology of ferments, whilst the remainder of the work includes a systematic classification of various types of ferment and enzyme action.

The production of this work is an achievement on which both Dr. Oppenheimer and Dr. Kuhn as well as the publishers, G. Thieme of Leipzig, are to be congratulated; for, if it accomplished no more than to serve as a digest of the enormous quantity of work that has appeared during the last decade alone, and published in the most diverse periodicals, on this complicated subject, it would have been of great value. Presenting in addition a careful formulation of the considered views of those who have made a detailed study of enzyme action, the volumes may well be considered indispensable to those interested in the subjects of chemistry and physics in their biological application.

E. K. Rideal.

Our Bookshelf.

Dr. H. G. Bronn's Klassen und Ordnungen des Tierreichs wissenschaftlich dargestellt in Wort und Bild. Sechster Band, Abteilung 1: *Pisces* (*Fische*). Bearbeitet von Prof. Dr. M. Rauther. Lieferung 39. Pp. 583-710 + v. 15 gold marks. Fünfter Band: *Arthropoda.* Abteilung 2: *Myriapoda.* Bearbeitet von Dr. K. W. Verhoeff. Lieferung 100. Pp. 539-666. 14·50 gold marks. Dritter Band: *Mollusca* (*Weichtiere*). Buch 2: *Pulmonata.* Bearbeitet von Dr. H. Simroth, fortgefuhrt von Dr. H. Hoffman. Lieferung 147. Pp. 737-832. 10·50 gold marks. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1924–25.)

Band 6, Abteilung 1 contains accounts of the Leptocardii and the cyclostomes contributed by four successive authors—Drs. Lònnberg, Favaro, Mozejko, and Rauther, the last named being responsible for this Lieferung 39 which completes the Abteilung. He has contributed the last dozen pages of the description of the urinogenital organs of cyclostomes, a clear account of the development and organogeny of Lampetra and of Bdellostoma and of the biology of the principal species, and a scheme of classification in which the characters of the known genera and species are concisely stated. A short discussion on variation and similar matters, some general observations on geographical distribution, and an appendix on the origin and relationships of cyclostomes, form the concluding part of the text. There is an adequate systematic and subject index. Opportunity might have been taken to refer in the appendix to memoirs by Cole and others which have been issued since the earlier parts of the volume were published.

Lieferung 100 (Band 5, Abt. 2) opens with an account of the systematic characters of the Geophilomorpha, the families, subfamilies, genera, and subgenera being concisely defined and tabular keys provided where necessary. Supplements on the Scolopendromorpha, Lithobiomorpha, and Notostigmophora—two suborders and a subclass which were dealt with in preceding sections of the work—bring the information on these up-to-date. A concluding chapter is devoted to a detailed consideration of the geographical distribution of the Myriapoda, including the delimitation of the European and Mediterranean subregions, and a comparison of the chilopod fauna of the eastern and western parts of the latter.

Lieferungen 95-146 of Band 3, Buch 2, were written by the late Prof. H. Simroth and published in 1908–14. The first fifteen pages of the present Lieferung (147) are from his manuscript, and complete the account of the development of the reproductive organs of the Pulmonata, and summarise the records of natural and artificially produced developmental abnormalities. Dr. Hoffmann is the author of the rest of the Lieferung. He contributes a list of some 750 works published subsequent to 1908, which forms a continuation of the lists given in earlier parts of the book. A number of memoirs dealing with Indian and other species seem to have escaped attention and are not included in the list. The remaining pages contain appendices which embody the results of work published during the last twelve years. References are given to the earlier pages of the book to which these supplementary accounts relate; *e.g.* on the form of the body, shell, and operculum, on the integument, connective tissue, muscle, mantle, and on secretion of the shell.

Faune de France. Par L. Berland. 10: *Hyménoptères vespiformes, I.* (*Sphegidæ, Pompilidæ, Scoliidæ, Sapygidæ, Mutillidæ*). (Fédération française des Sociétés de Sciences naturelles: Office central de Faunistique.) Pp. viii + 364. (Paris: Paul Lechevalier, 1925.) 45 francs.

The author of this volume includes in the Vespiformes all wasp-like Aculeates other than the Chrysididæ. The present contribution deals with the five families Sphegidæ, Pompilidæ, Scoliidæ, Sapygidæ, and Mutillidæ, or, in other words, the fossorial forms. Owing principally to insufficiency of reference material, the Bethylidæ are not included, and their treatment is postponed until the appearance of a second volume which is in course of preparation. M. Berland has, for the first time, provided a comprehensive account of the 450 species of French fossorial wasps, and has accomplished his task with notable success. As in previous volumes of the series, full use is made of generic and specific keys, while each genus and species is also separately diagnosed. Under every species there is given a résumé of its distribution and of the chief facts relating to its biology. The biological notes are especially useful, since the author has sifted the literature of the subject with very evident care, and we know of no other work where similar information is available in an equally concise form. As M. Berland remarks, the study of the habits of Hymenoptera is more especially due to French observers, among whom the names of Latreille, Lepeletier, Dufour, Fabre, and Ferton are recalled. The author has wisely dispensed with long detailed lists of synonymy, and has left those who are curious on this subject to refer to the catalogue of Dalla Torre for all questions of nomenclature prior to 1897.

The book is profusely illustrated with 663 text figures, and, with the exception of Figs. 17-19 and 305, all are the original work of M. Berland. The various structural details which are thus represented add materially to the value of the book, and although many of these illustrations appear somewhat wooden in character, they nevertheless fulfil their purpose. We can recommend the book as one which should find a place on the shelves of English entomologists. A. D. I.

(1) *The Animals of New Zealand: an Account of the Dominion's Air-breathing Vertebrates.* By Capt. F. W. Hutton and James Drummond. Fourth edition, revised and enlarged. Pp. 434. (Auckland, Christchurch, Dunedin, Wellington, Melbourne and London: Whitcombe and Tombs, 1923.) 15*s*.

(2) *A Synopsis of the Vertebrate Animals of Tasmania.* By Clive E. Lord and H. H. Scott. Pp. v+340+41 plates. (Hobart: Oldham, Beddome and Meredith, 1924.) n.p.

(3) *Red Deer Stalking in New Zealand.* By T. E. Donne. Pp. xii+270+32 plates. (London, Bombay and Sydney: Constable and Co., Ltd., 1924.) 21*s*. net.

(1) IT is with pleasure that we welcome a new edition of Hutton and Drummond's "Animals of New Zealand." This is a well-written and well-illustrated account of a most interesting fauna, indispensable to all concerned with the vertebrate life of the southern hemisphere. It should do much to stimulate local interest and so help those who are endeavouring to preserve the fauna and flora of the Dominion.

(2) Mr. Lord and Mr. Scott are to be commended for their "Synopsis of the Vertebrate Animals of Tasmania." This work gives a concise account of all the vertebrates known to inhabit the island and the surrounding seas. Its illustrations are satisfactory and the volume contains a great deal of valuable information concerning the habits and distribution of many species. Some useful notes on mammalian osteology are incorporated in the text. Incidentally, here and there, the authors tell a good story, and that relating to the Hobart policeman who tried to arrest a sea-leopard, in the small hours, as 'a drunk and incapable,' is particularly pleasing.

(3) Though "Red Deer Stalking in New Zealand" is naturally a book for the sportsman rather than the zoologist, the latter will find in it a good deal of information relating to the present status of the red deer and of the many other species of deer that have now been introduced and acclimatised in New Zealand. Some very good photographs of heads from the Dominion, accompanied by measurements, add materially to the interest of the book.

A List of British Aphides (including Notes on their Synonymy, their recorded Distribution and Food Plants in Britain, and a Food-Plant Index). By Dr. J. Davidson. (The Rothamsted Monographs on Agricultural Science.) Pp. xi+176. (London: Longmans, Green and Co., 1925.) 12*s*. 6*d*. net.

THE volume under notice is the fourth of the recently instituted series of "Rothamsted Monographs on Agricultural Science," and is the first to treat of an entomological subject. The morphological characters separating allied species of aphides are often comparatively trivial, and this fact, coupled with polymorphism and a certain plasticity of host-selection, has led to much confusion in the identification of these insects. Their involved nomenclature has been badly in need of revision, and in many cases it has become a difficult task for the entomologist, who was not a professed aphidologist, to make certain of the genus or species to which a given name is strictly applicable.

Since the 'List' before us is a product of the activities of the Rothamsted Experimental Station, its object is more especially to facilitate the labours of workers in agricultural science. From this aspect only (even if there were no other) the accurate determination of species of aphides is of particular importance. This fact has in recent years acquired additional significance owing to the discovery that certain species of aphides, and apparently no others, are concerned with the transmission of mosaic disease in the case of the raspberry, tomato, potato, and sugar-cane. Dr. Davidson has done a useful service in providing synonymic lists of all the British species and genera of aphides in the light of recent taxonomic changes. The specific names are alphabetically arranged and amount to nearly 400, and the number of genera recognised is 87. The long list of plant genera and species, with the aphides recorded from them, should prove especially helpful. The first clue to the possible identity of a particular species of aphid is commonly obtained by noting, in the first instance, the plant upon which it is found. The book concludes with an extensive bibliography of all the more important papers on these insects.

Exercises in Practical Physics. By Sir Arthur Schuster and Prof. C. H. Lees. Fifth edition, revised. Pp. ix+373. (Cambridge: At the University Press, 1925.) 12*s*. 6*d*. net.

IT is some twenty-five years since the first edition of this book was reviewed in these columns. In several subsequent editions, including the present one, it has undergone some revision, chiefly necessitated by the steadily rising standard of the courses for which it was intended. It is a long life for any physics text-book, and such longevity is in itself the most eloquent of tributes to its many merits. Yet there may be some who will find lingering about it a suggestion of an old-world atmosphere, as it were, which a modern interpolation or two (the thermionic valve, for example) merely emphasises instead of dispelling. Still, it is difficult to support such an accusation—if it be an accusation—by specific instances. What is indisputable, on the other hand, is the admirable soundness and thoroughness which characterise the book throughout. Of particular value is its insistence on the consideration of order of accuracy of measurements and results, for this is an aspect of laboratory instruction which is apt to suffer nowadays from the congested condition of practical syllabuses. Students who work conscientiously through this book, even without assistance from a teacher, will have laid a very secure foundation for more advanced experimental work in physics.

At the same time, one cannot but wish that the scope had been more comprehensive. It is true that there are sufficient experiments to constitute a satisfactory course, but no two teachers would be likely to select exactly the same experiments as being best suited to their special circumstances, and the book would therefore have been much more generally useful had it contained a wider range of experiments, from which selection could be made as required.

Zoologie im Grundriss. Von Prof. Dr. Walter Stempell. Erste Lieferung. Pp. xviii + 160. 6·60 gold marks. Zweite Lieferung. Pp. 161-336. 6·90 gold marks. (Berlin: Gebrüder Borntraeger, 1925.)

THESE two parts are devoted to accounts of the morphology, structure, and classification of animals from Protozoa to Chordata, and the author has been faced with the problem of what to include and what to omit—as are all writers of text-books, and each author has his own views on the subject. But is seems difficult to justify the inclusion of even short accounts of relatively rare parasites of man, the affinities of some of which (*e.g.* Rhinosporidium, the Spirochætes, and the Chlamydozoa) with the Protozoa are more than doubtful. The brief description and single figure of the Mesozoa can be of little use, and the same may be said of the characterisations in two or three lines of many of the families of cœlenterates and other Metazoa. It is evident the author has carefully rationed himself in his descriptions of the more important organisms in regard to many of which further detail would have been helpful. The extent of the compression may be judged by citing as examples the Prototracheata, which are dealt with in 20 lines of text and 4 figures, the Scyphozoa in 30 lines and 5 figures, the rotifers in 26 lines and 2 figures, the Diptera in 15 lines and 4 figures; there are short descriptive legends to most of the figures.

The parts on the Mollusca and the Chordata are, on the whole, more satisfactory. The illustrations are usually well chosen and well reproduced, and many of them are original. It should have been possible to give better figures of Entamœba, the Spirochætes, the larva of Filaria and *Pulex irritans.*

The table of contents shows that the succeeding parts are to deal with physiology, development, biology, distribution, and phylogeny, on which there is room for a good text-book. We shall look forward with interest to the author's mode of treatment of these important subjects.

Ostwald-Luther Hand- und Hilfsbuch zur Ausführung physikochemischer Messungen. Herausgegeben von C. Drucker. Vierte neubearbeitete Auflage. Pp. xx + 814 + 3 Tafeln. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1925.) 35 gold marks.

OSTWALD'S "Hand- und Hilfsbuch" has changed almost beyond recognition since it was first issued in 1893. It was then a comparatively small book, and the reviewer remembers vividly how as a student he used it as a text-book of scientific German. The second edition, issued in 1902, called for the services of a collaborator in the person of Prof. Luther; and now, fifteen years after the appearance of the third edition, the issue by Prof. Drucker of a fourth edition has only been possible with the aid of a long list of collaborators, who have contributed complete sections on optical measurements, X-ray measurements, radioactive measurements, etc. Including the indexes, the whole volume now covers more than 800 pages, and it would have been still larger but for the fact that, in the opinion of the responsible editor, the appearance of the "Kolloidchemische Praktikum" of Wo. Ostwald has rendered it no longer necessary to add a section on the technique of colloid chemistry. In the same way the revision of the "Physikalisch-Chemischen Tabellen" of Roth and Scheel has made it possible to omit most of the numerical data. The details of the practical course at Leipzig (which includes fourteen electrical exercises, but only one optical experiment, with a sodium lamp as the only light-source) have, however, been retained as an appendix.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. Emil Abderhalden. Lieferung 173. Abt. 9: *Methoden zur Erforschung der Leistung des tierischen Organismus,* Teil 2, 1 Hälfte, Heft 2. *Methoden der Süsswasserbiologie.* Pp. 285-542. (Berlin und Wien: Urban und Schwarzenberg, 1925.) 10·80 gold marks.

THE second part of the "Methoden der Süsswasserbiologie" is a further instalment of that indispensable work "Handbuch der biologischen Arbeitsmethoden," edited by Prof. Emil Abderhalden, and continues the description of freshwater biological methods begun in Part 115. The present portion begins with the rearing of freshwater insects of all groups, followed by other invertebrates. In such experimental work, the knowledge of the food required by the animals in question is essential, and a large amount of exact information is given as to the feeding at every stage. The culture of certain invertebrates as fish food has now become a matter of extreme importance, and special prominence is given to the small crustacea such as the Cladocera, a separate chapter being given to *Daphnia magna* Straus. Then follow a long treatise on the rearing of freshwater fishes, more especially carp and trout, although others are also mentioned; a most interesting account of the methods of investigating the history of lake bottoms by means of samples taken by boring tubes and tube sounding leads; and finally chapters on boats for scientific work in inland lakes and a description of the working of the biological station at Lunz in the Austrian Alps. As each section is by an expert in his own line, we have an up-to-date account of all recent research methods which is of inestimable value to all freshwater biologists.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Motion of the Spinning Electron.

IN a letter published in NATURE of February 20, p. 264, Messrs. Uhlenbeck and Goudsmit have shown how great difficulties which atomic theory had met in the attempt to explain spectral structure and Zeeman effects, can be avoided by using the idea of the spinning electron. Although their theory is in complete qualitative agreement with observation, it involved an apparent quantitative discrepancy. The value of the precession of the spin axis in an external magnetic field required to account for Zeeman effects seemed to lead to doublet separations twice those which are observed. This discrepancy, however, disappears when the kinematical problem concerned is examined more closely from the point of view of the theory of relativity.

As usual, letters in heavy type will denote vectors. The anomalous Zeeman effect seems to require that the spin axis of the electron precesses about an external magnetic field $\mathbf{H}$ with angular velocity

$$\frac{e}{mc}\mathbf{H}, \quad . \quad . \quad . \quad . \quad (A)$$

where c is the velocity of light and $-e$, m are the electronic charge and mass. Suppose such a spinning electron moves with velocity $\mathbf{v}$ through electric field $\mathbf{E}$. At first sight it would seem that, being subject to magnetic field

$$\mathbf{H}=\frac{1}{c}[\mathbf{E}\times\mathbf{v}],$$

the spin axis will precess about the instantaneous normal to the orbital plane with angular velocity

$$\frac{e}{mc^2}[\mathbf{E}\times\mathbf{v}]. \quad . \quad . \quad . \quad . \quad (B)$$

As the mean value of this expression is just twice the angular velocity with which the perihelion of the orbit rotates on account of the variation of mass of the electron, this would lead to twice the observed doublet separation.

There is, however, an error in the above reasoning; the precession of the spin axis so calculated is its precession in a system of co-ordinates (2) in which the centre of the electron is momentarily at rest. System (2) is obtained from system (1), in which the electron is moving and the nucleus at rest, by a Lorentz transformation with velocity $\mathbf{v}$. If the acceleration of the electron is $\mathbf{f}$, and system (3) is obtained from system (1) by a Lorentz transformation with velocity $\mathbf{v}+\mathbf{f}dt$, then the precession which an observer at rest with respect to the nucleus would observe, and which should be summed to give the secular precession, is that precession which would turn the direction of the spin axis at time t in (2) into its direction at time $t+dt$ in (3) if both directions were regarded as directions in (1). To a first approximation system (3) is obtained from system (2) by a Lorentz transformation with velocity $\mathbf{f}dt$ together with a rotation $(1/2c^2)[\mathbf{v}\times\mathbf{f}]dt$. Thus the observed rate of precession will be, to a first approximation,

$$\frac{e}{mc^2}[\mathbf{E}\times\mathbf{v}]-\frac{1}{2c^2}[\mathbf{v}\times\mathbf{f}].$$

To a first approximation

$$\mathbf{f}=-\frac{e}{m}\mathbf{E},$$

so the rate of precession is

$$\frac{e}{2mc^2}[\mathbf{E}\times\mathbf{v}], \quad . \quad . \quad . \quad . \quad (C)$$

just half the expression (B).

The interpretation of the fine structure of the hydrogen lines proposed by Messrs Uhlenbeck and Goudsmit now no longer involves any discrepancy. In fact, as Dr. Pauli and Dr. Heisenberg have kindly communicated in letters to Prof. Bohr, it seems possible to treat the doublet separation as well as the anomalous Zeeman effect rigorously on the basis of the new quantum mechanics. The result seems to be full agreement with experiment when the calculation is based on formulæ (A) and (C).

I hope in a later paper to develop the above kinematical argument in greater detail.

In conclusion, I wish to express my appreciation of the encouragement and help of Prof. Bohr and Dr. Kramers.

L. H. THOMAS.

Universitetets Institut for Teoretisk Fysik,
Copenhagen, February 20.

Genes and Linkage Groups in Genetics.

NOW that Prof. MacBride has delivered himself of his final reply to Prof. Huxley on the subject of linkage and genes, I should like to offer a few comments on a point from which further confusion might easily arise in the future. It concerns the use of the word 'linkage.' This term was originally proposed by Prof. Morgan, and the first evidence of its appearance in print that I have been able to find is in the title of a paper published in the *Biological Bulletin* for August 1912 by T. H. Morgan and Clara S. Lynch on "The linkage of two factors in Drosophila that are not sex-linked." In the previous year Mr. Bateson and I had shown that what we had hitherto termed 'coupling' and 'repulsion' were in reality phases of the same phenomenon, and we subsequently adopted Morgan's term as a convenient one for the phenomenon as a whole. In this matter the United States and Europe saw eye to eye, and henceforward the term 'linkage' in this definite and precise sense has been in use by geneticists all the world over.

Before a case of association between characters in the hereditary process can be assigned to the category of linkage, it must be shown (1) that each character, followed separately, shows normal segregation in the Mendelian sense, and (2) that the relative distribution of the characters in a given generation differs in orderly fashion according as their gametic representatives entered the parental zygote together or apart. Only when these conditions are observed are we entitled to speak of a case as exhibiting the phenomenon of linkage.

Here it seems to me that Prof. MacBride becomes definitely misleading. In his letter of March 6, p. 340, he cites as a case of linkage the effects produced in the developing vertebrate embryo by alterations in amniotic pressure. No doubt such alterations produce simultaneous and definite effects in various organs. Such a statement, coming from such an authority on matters embryological, I do not dream of questioning. But when Prof MacBride cites this as an example of linkage, I assert that he has no right to do so until he, or some one else, has proved that it fulfils the conditions necessary to bring it under the heading of this phenomenon. Until this has been done, the case, interesting as it may be in other connexions, is here worthless. For it is quite likely that it has nothing whatever to do with linkage.

Mr. Tate Regan, too (NATURE, Jan. 16, p. 86), has fallen into the same error when, in flat fishes, he describes ambicoloration, monomorphic scales, and delayed migration of the eye as a linkage group. That these variations tend to occur together is well recognised, but here again we know nothing of their hereditary behaviour; and until we have some knowledge of this it is beside the mark to bring them forward. As Prof. Huxley suggests in his letter of February 20, p. 268, they may quite well be all dependent upon the operation of the same genetical factor. In the white sweet pea the colourless flower is always associated with a green axil and a pale brown seed coat, and these three associated characters can all be referred to the absence of one of the ingredients necessary to the production of anthocyan pigment. These associated characters, as experimental evidence has clearly shown, do *not* constitute a linkage group, and I suspect that this is more likely than not to be true also of Mr. Tate Regan's example. Further, in view of Mr. Tate Regan's later note of March 6, p. 341, I would add that the simultaneous appearance of mutations is, in so far as we know, quite unconnected with linkage. That such simultaneous mutations may show linkage is of course possible, but in all probability it is more likely that they will not.

In conclusion, I would lay further stress upon what Prof. Huxley has already clearly pointed out, namely, that the recognition of the orderly series of phenomena to which the term linkage has been applied does not necessarily entail acceptance of the chromosomal theory of heredity. That this theory at present offers the most plausible interpretation of linkage is admitted by the great majority of those who are best qualified to judge. Yet if the chromosomal theory were to be swept away to-morrow, the precise and clear-cut phenomenon of linkage would remain untouched.

R. C. PUNNETT.

Whittingehame Lodge, Cambridge.

The So-called Dielectric Constant.

IN NATURE of March 6, p. 361, an abstract of an address by Prof. Compton, entitled "Dielectric Constant and Molecular Structure," is given.

So early as 1889 it was known that dielectrics conduct electricity (see Curie, *Annales de Chimie et de Physique*, 1889), and that the so-called constant depends upon the time of charging, and when measured by the alternating method, upon the frequency (J. J. Thomson, *Roy. Soc. Proc.*, 1889).

I have shown (*Roy. Soc. Proc.*, 1915 and 1925) that when a potential v is applied to one surface of a condenser, the other surface being connected to the earth, the relation between the charging, polarising, and conduction currents is represented by

$$\gamma = \frac{dQ}{dT} + \frac{v - P}{R} \quad . \quad . \quad . \quad . \quad (1)$$

where γ = the charging current,

$\frac{dQ}{dT}$ = the polarising current (*i.e.*, the rate at which the charge is accumulating in the dielectric),

P = the electromotive force of polarisation of the dielectric,

and R = the true electrical resistance of the dielectric in the given circumstances.

After the current has been flowing for some time, $\frac{dQ}{dT}$ becomes negligible and the equation reduces to

$$\gamma = \frac{v - P}{R} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

For the discharge the equation reduces to

$$-\frac{dQ}{Td} = -\frac{P}{R} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Röntgen and Joffé (*Annalen der Physik*, vol. 72, 1923) have experimented on numerous substances (including pure crystals) in widely varying circumstances as to voltage and temperature, and their results confirm both (2) and (3).

I, myself, having performed many experiments (at constant temperature) on quartz along and across the optical axis, fused quartz, Iceland spar, rocksalt, glass, paraffin, ebonite, and xylol, have come to the conclusion that if one surface of a condenser be connected to the earth and the other surface be maintained at a potential v for a time T, the total charge accumulated in the condenser can be represented by

$$(K + K'_\tau)Cv,$$

where C = a constant depending on the size and arrangement of the conducting surfaces,

K = the specific inductive *instantaneous* capacity of the dielectric,

K'_τ = the *maximum* value of the specific inductive *residual* capacity,

and τ = the time taken for the potential of the surface originally at potential v (when connected to the earth) to fall to zero.

At any subsequent time, t (greater than τ), the charge remaining in the condenser, can be represented by

$$K_t'Cv,$$

where $$K'_t = nK_\tau' e^{x - a(t-\tau)}$$

and n = a constant for the given *specimen* of dielectric,

a = a function of T (the time of charging),

x = a function of both T and t.

When the discharge has taken place for some time this expression reduces to

$$K'_t = nK_\tau' e^{-at}.$$

The general behaviour of dielectrics is, however, at present little understood and cannot, I think, be represented adequately by any kind of simple model.

S. W. RICHARDSON.

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The Relation of Weight to Height during Adolescence.

AMONG the well-known anthropometric formulæ due to Prof. Dreyer of Oxford (see *Lancet*, August 9, 1919, and NATURE, August 26, 1920), there is one connecting weight, W, with stem-length, or height of trunk alone, λ, namely, $W = 0{\cdot}380\sqrt[0{\cdot}319]{\lambda}$. This gives a ratio of the type $W^n/\lambda = K$, and is of special interest because, when dealing with averages of large numbers, it seems to show surprisingly little variation with age during the important adolescent period of life. To test it I used data relating to Manchester Grammar School boys, for which I am indebted to Dr. Mumford, Medical Officer of the School. The school measurements of height and weight have been taken on a uniform basis for about forty years; measurements of stem-length were taken in addition in 1921 and 1923. If the stem-length is replaced by the full height (H), and if 0·319 (n) is replaced by the approximate value ⅓ in Dreyer's formula, I find that the ratio is even less variable. Table 1 shows the values of $W^{\frac{1}{3}}/H$, calculated from the mean values of W and H, for groups of boys varying in age from 9 to 19 years at three different periods of time. In the same table are shown, for comparison, calculations of the same ratio for Schuster's observations of undergraduates, and of $W^{0\cdot 319}/\lambda$ for the Grammar School boys in 1921, 1923. Measurements were expressed in C.G.S. units, but significant figures only are printed.

In order to get a more precise measure of the variability, the standard deviations of the 1921, 1923 values of $W^{\frac{1}{3}}/H$ and $W^{0\cdot 319}/\lambda$ at different ages were also determined, being measured from the weighted means of all the observations in each case. To render them comparable, these standard deviations were expressed as percentages of the corresponding weighted means; the resulting coefficient of variation for $W^{0\cdot 319}/\lambda$ was 0·66 per cent and for $W^{\frac{1}{3}}/H$ was 0·37 per cent. This is a further corroboration of the conclusion to which Mumford and Young came (*Biometrika*, August 1923): "Despite the definite tendency shown in recent work on the inter-relationships of the physical measurements to replace the full-length by the stem-length, the latter does not possess the many advantages over the former that have been frequently claimed or asserted. It would almost appear to be a matter of indifference as to which measurement of length is used"

TABLE 1.

Variability of $W^{\frac{1}{3}}/H$ and $W^{0\cdot 319}/\lambda$ at Different Periods and Ages.

Age	Number of Boys Observed.			$W^{\frac{1}{3}}/H$.			$W^{0\cdot 319}/\lambda$.	Schuster's Undergraduates.		
	1881–86	1905–10.	1921, 3.	1881–86.	1905–10.	1921, '23.	1921, '23	Age.	Number.	$W^{\frac{1}{3}}/H$.
9-	38	17	..	228	230	.	..			
10-	124	85	.	229	230	..	..	18-	129	229
11-	356	256	60	228	229	228	421	19-	330	229
12-	353	340	204	227·5	227	226 5	420	20-	209	229
13-	672	470	339	227	226·5	228	424			
14-	704	473	496	227	226	227	422	21-	137	229 5
15-	668	340	551	227	226	226	419	22-	95	230
16-	347	432	388	227	227	226	417			
17-	115	187	165	226	227	227	415	23-	59	229
18-	32	88	68	227	229	228	415			

TABLE 2.

ELEMENTARY SCHOOL-BOYS IN LIVERPOOL (1923).

Comparison of Values of $W^{\frac{1}{3}}/H$ at Different Ages according to Class of District.

Age.	Class of District. (Number of Observations.)			Class of District. ($W^{\frac{1}{3}}/H$).		
	Poor.	Fair.	Good.	Poor.	Fair.	Good.
5½	222	363	236	254	249	245
6½	147	195	209	249	246	242
8½	413	539	412	242	240	234
12½	420	461	317	234	232	235
13½	175	124	94	233	232	230

It may be stated that the ratio $W^{\frac{1}{3}}/H$ was also worked out individually for a random sample of 50 boys in the same school in the summer of 1924. The boys varied in age from 13 to 19 years. There were two exceptional boys in the group for whom the ratio was so high as 244 and 260 respectively; for the rest, it varied between the limits 216 and 238. For the whole group the lower and upper quartiles were 224 and 233; the arithmetic mean was 229; the standard deviation, 74·7; and the coefficient of variation, 3·3 per cent.

The formula $W^{\frac{1}{3}}/H = K$ is a well-established one. Quetelet himself said that the weight of the human body, if it were symmetrical, would vary as the cube of the height, though his observations led him to the opinion that "in general, we do not err much when we assume that, during development, the squares of the weight at different ages are as the fifth powers of the heights." Hutchinson, later, decided that W varied as the 2·75th power of H. Livi had introduced the ratio $W^{\frac{1}{3}}/H$ into general and comparative anthropometry under the name "ponderal index," and it has been used on the Continent for many years as an index of nutrition among school children.

Table 2 may be of interest as bearing on the nutrition question. It analyses the values of $W^{\frac{1}{3}}/H$, calculated upon the mean values of W and H, for elementary school-boys in Liverpool, at different ages from 5 to 14 years, according to the class of district where each school is located. (Data from the Report of the Medical Officer, Liverpool, 1923.) Note that the index during these early years falls as the age increases and, if we may assume that the boys from the better districts are the better nourished, the index also falls as the nutrition increases. To this there is only one exception, namely, in the 'good' district at age 12½ years.

It is doubtful, however, whether the claim to treat $W^{\frac{1}{3}}/H$ as a trustworthy index of nutrition has ever been properly established. Other factors certainly affect the index besides nutrition, for example, muscular activity, hours of sleep, and home conditions generally; exercise under healthy conditions promotes growth in height and weight, but absolute rest with a nourishing diet likewise promotes growth; some illnesses seem to have a stimulating effect on the growth of the skeleton, perhaps by removing the muscular tension which acts on bone. But apart from its possible value as a nutrition index, more especially in dealing with children somewhere near the poverty line, the ratio $W^{\frac{1}{3}}/H$ might serve a useful purpose as the basis of a table, like the Dreyer tables, connecting weight, stem-length, vital capacity, and chest girth, providing a gauge of the approximate weight to be expected in a normal boy of given height and given class.

D. CARADOG JONES.

School of Social Science,
University of Liverpool,
January 30.

References and Re-paging of Reprints.

AGAINST the re-paging of reprints, the British Association Committee on Zoological Bibliography and Publication has protested since its foundation in 1895, and it has always taken the view that this and similar matters are in the control of editors, to whom accordingly its recommendations have been addressed. It is therefore refreshing at last to find an editor, in the person of Dr. Rastall, associating himself so whole-heartedly with the protest (NATURE, March 20, 1926, p. 418). *Experientia docet.*

In the same number of NATURE (p. 425), in allusion to the work of the Bureau of Chemical Abstracts in "endeavouring to secure uniformity in the method of referring to original papers," you justly say that "on questions common to all sciences the views of other bodies . . . must be considered." Here again the above-mentioned British Association Committee has for many years past urged the general adoption of a method already widely in use among biologists, especially in the United States. Here the order is:

author, date, title, journal, series, volume, page. The committee advocates giving the year number in full, since zoology at any rate neither began nor ended with the nineteenth century. If this be done and a logical order followed, both 1825, 10, 6, and 6, 10, 1825 are equally intelligible, though personally I prefer 'Oct.' to '10' or 'X.' The intercalation of the date between volume and page-numbers is illogical and often misleading.

F. A. BATHER,
Sec. B A. Committee Zool. Bibl.

March 20.

I THOUGHT that this pernicious custom had long ago disappeared for ever. Any one who has occasion to refer to the long series of papers on the Nomenclature of the Foraminifera in the *Am. Mag. Nat. Hist.*, 1859–72, will cordially endorse Dr. Rastall (NATURE, March 20, p. 418). References to these in synonymies are made indifferently to the journal and its reprints, and it is never safe to rely upon them.

There exists, however, a far more ghastly crime than the mere re-pagination of reprints. One looks with suspicion on a page reference (say 1-20), but one is tempted to accept as 'original' page references (say) 100 *et seq.* But the late Charles Schlumberger used to have his reprints paged consecutively—*and left out his own pagination when he was not allowed to do so*, and took it up again when he was. The awful result was as follows. His first paper was re-paged 1-3; his second was not re-paged, and he allowed for this in his third, which was re-paged 10-19 with a second part paged 20-23, *and he allowed for his new title wrappers*, so his next was re-paged 27-34, the next 35-37, the next 39-89, and so it went on until 1894, when he had reached pp. 237-243, an unre-paged reprint, which had its original pagination 118-123, coming between pp. 222 and 237. After this, probably yielding to infuriated pressure, he abandoned the system, but the mischief was done, and no page reference to any of his twenty-one papers (up to 1894) is to be accepted without reference to the original journal.

It would be interesting to know whether any other writer ever committed this outrage upon posterity

EDWARD HERON-ALLEN.

The Evolution of Rosa.

THE recently published paper of Dr. C. C. Hurst ("Experiments in Genetics," 38, 1925) on the chromosomes and characters in Rosa may well mark a new epoch in biology. We must await the appearance of his monograph for full details, but as he suggests, we may in the meanwhile try to apply the 'Rosa principles' to other plants and animals. It is suggested that the common ancestor of all roses was a northern decaploid species, at present unknown. The various forms could have arisen by the dropping out of sets of chromosomes, the existing five diploid types being the end-products of this process. We are told, however, that "certain cultivated triploid and tetraploid forms are obviously duplicated forms which have arisen . . . by duplication of the septets of chromosomes." These maintain the essential specific characters of the original diploid species, instead of showing a complex of the characters of diverse septets. Is it not possible to suppose that this duplication may have been the first step in the production of polyploid species, the latter acquiring the diverse septet characters by successive mutations? The Drosophila work has shown that mutations are likely to be lethal or unfavourable. In a diploid species such mutations should apparently work more havoc than in a polyploid one. Polyploidy might then be a condition favouring the survival and accumulation of mutated genes, resulting after very long periods of time in diversity of the septets. Such diversity might come to have its advantages, as Dr. Hurst indicates, in specific cases. On the other hand, in some cases the shedding of a septet might be advantageous, getting rid of some undesirable features, and producing a more uniform or consistent type. Thus the diploid *R. rugosa*, which I found to be a strictly sea-coast plant in Siberia, is a well-defined type specially adapted to its peculiar habitats but not extending even a few miles inland. Yet it is not to be expected that the diploids will all be successful, and close field study combined with cytological research may be expected to reveal a variety of forms with reduced chromosome numbers, coming into existence only to perish at once or in a few years. Many, probably, may not even be capable of development.

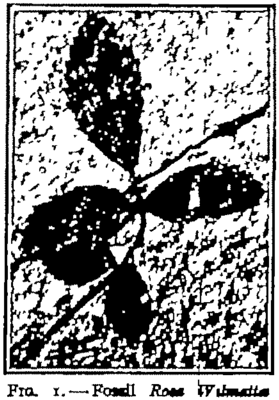

FIG. 1.—Fossil *Rosa Wilmattae* Cockerell, from the Miocene of Florissant, Colorado.

Possibly, then, there is a double process going on, and it may not appear certain that the original rose was decaploid, though the existing diploids may all be derived from polyploid ancestors. There has been time for much to happen, for we know from the Miocene of Florissant several species of roses extraordinarily like those of the present day (cf. Fig. 1).

T. D. A. COCKERELL.

University of Colorado,
March 4.

The Banana in America.

As a student of culture-history I must protest against the inferences drawn by Dr. E. W. Berry from the finding of fossil banana seeds in Tertiary beds in Colombia which were referred to in NATURE, February 6, 1926, p. 209.

The moot-problem resolves itself into two questions. What is the value of the early references to the banana as a plant cultivated by the natives prior to the possible introduction of the cultivated banana? And, what follows from the indigenousness of the wild banana as to its cultivation by the aborigines? The 'historical evidence' for the pre-Colombian cultivation of the banana is considered quite unconvincing by such authorities as Baron Erland Nordenskiold, who writes: "It may be regarded as proved by De Candolle and Karl v. d. Steinen that the banana was introduced into America by the whites" ("Comparative Ethnographical Studies," vol. 5, 1922, 64 *sq.*). On the other hand, the conclusion that *if* the banana was indigenous in America it must have been cultivated by the natives is a monstrous *non sequitur* that might be labelled a typical 'botanist's fallacy,' were the sobriquet not unjust to many botanists keenly alive to the historical questions involved in the history of cultivation. This methodological question has been so adequately treated in Dr. B. Laufer's "Sino-Iranica" (Chicago, 1919), that I will here content myself with a reference to that treasure-trove of information. It no more follows that, say, the Peruvians would cultivate a wild plant found in their territory than that the Eskimo would domesticate the caribou. As Laufer has shown, the Chinese had the wild walnut and a wild vine, but it never occurred to them to cultivate either.

Though the botanical aspects of the question are beyond the sphere of my competence, I should like to refer the reader to E. Werth's paper on the banana ("Zur Natur- und Kulturgeschichte der Banana,"–in *Festschrift Eduard Hahn*, 1917, 22-50). The author shows—satisfactorily, so far as a layman can judge—that the African wild species, *Musa ensete*, could not by any possibility have given rise to the cultivated banana. So far as I remember the report of Dr. Berry's paper in *Science*, his Colombian banana is of the African type and must accordingly be ruled out as a possible ancestor of the cultivated forms.

Robert H. Lowie.

University of California,
Berkeley, California.

Phyllody in the Primrose Flower.

Through the medium of the columns of Nature, may I record the occurrence in this neighbourhood of a pair of plants of *Primula Vulgaris* (Huds.), both of which illustrate the phenomenon of phyllody of the sepals.

The calyx is the whorl of floral leaves chiefly involved. The teeth of the calyx, normally narrow and sharply pointed, have become revolute, acuminate, miniature leaves above the tubular portion, while this latter part has—but for slight increase in size—retained the normal tubular form, the veins being rather more obvious. Tracing this increase in foliar characters in the sepals through several flowers, it was noticed that the increase is accompanied by a decrease in the size of the individuals of the corolla.

The stamens (the flowers in every case in both plants were 'thrum-eyed') and pistil were in all cases normal in appearance, but the more the reversion characters were developed in individual flowers the shorter was their duration. Normal flowers on normal plants are still flowering while the diminutive corollas and staminate parts of the retrogressive flowers withered within four days of opening.

The measurements of the foliar sepals are: 1·45 cm. from top of calyx tube to acuminate point; 1·20 cm. broad at the greatest breadth. These figures represent the average for the five sepals of the flower exhibiting the greatest reversion. The average diameter of the most abnormal flower is 3·2 cm., measuring across the sepal expansion.

The plants are being maintained in the laboratory here, and will be watched through subsequent seasons. The seeds of the abnormal flowers will be sown.

F. R. Browning.

Bedales School, Petersfield,
March 13.

The Crystalline Style and Anaerobic Respiration.

The review of the *Journal of the Marine Biological Association* (vol. 13, No. 4) in Nature of January 2, p. 31, has directed my attention to the very interesting paper by Dr. Yonge on the hydrogen ion concentration in the gut of certain lamellibranchs and gastropods. In the course of this paper Dr. Yonge criticises my suggestion (*J. of Exp. Zool.*, vol. 37, p. 477) that the disappearance of the crystalline style from certain marine molluscs when they are kept under anaerobic conditions may be, in part, a direct response to the lack of oxygen. Dr. Yonge holds that the disappearance of the style is "probably due to a lowering of the vital activities" of the animals, amongst which the secretion of the style-forming material is one, and that in the case of an animal the vital activity of which is thus reduced, the secretion cannot keep pace with the consumption of the style substance for digestive purposes. The style consequently disappears.

The evidence which Dr. Yonge and others have brought forward seems to leave it beyond doubt that the crystalline style plays an important part in digestion, but this does not exclude the possibility that it may also be connected with, and affected by, anaerobic respiration. Dr. Yonge's experiments do not seem to have been designed to differentiate the two possible functions, since the only methods employed by him to lower the vital activity of the animals with which he worked involved keeping them under anaerobic conditions. May not the resulting dissolution of the style be an expression of an effort on the part of the animal to offset the strain on its vital activity induced by anaerobiosis as well as by the necessity to maintain the acid condition of the gut for the purpose of digestion? The facts that the style disappears under anaerobic conditions and is regenerated by aeration *in the total absence of food material to digest* seems rather to point in that direction.

It seems to me that the matter must be considered *sub judice* until a series of experiments can be designed to follow the possibly manifold functions of the style independently of one another.

C. Berkeley.

The Biological Station,
Nanaimo, B.C., Canada,
February 4.

Renewed Activity of Cameroon Mountain.

Cameroon Mountain, which has been more or less dormant since the last eruption in 1922, has recently been showing signs of renewed activity The following extract from a letter by Mr. E. J. Arnett, Senior Resident, Cameroons Province, dated November 30, 1925, may be of interest to readers of Nature:

"You may be interested to know that the summit of the mountain is showing more signs of activity than for some time past. There is a large old crater on the west side of the summit about 400 yards in diameter and 150 feet deep. From its western and southern lip the ground falls rapidly away, and this face of it is visible from the 12,000-foot ridge as the mountain is ascended from Buea. This south-west face was seen to be white with fresh ash and steaming when I ascended the mountain on 29th instant accompanied by Mr. J. C. Drummond-Hay and Mr. C. W. Seed, Auditor.

"On reaching the top we found the whole circumference of this crater was white and steaming and the ground hot to the tread for some way back, with many small fissures giving out steam. The bottom of the crater was evidently cold, as the lichen-covered rocks which appeared to have fallen from the lip were fresh and green.

"Beyond the summit, *i.e.* north-west of it, between it and an almost equally high peak, there is a long valley or crater in which are a number of recently formed circular pits varying in diameter from 3 to 20 feet. These, it appears, have been formed during the past three months, but are now quite cold and black. There are about a dozen of these holes in a rough line running south-east and north-west."

J. D. Falconer.

Geological Survey, Nigeria,
February 8.

Diatoms and Flocculent Matter.

In old microscopical journals, one frequently finds the query "How can I get rid of flocculent matter in preparing diatoms for mounting?" and as a rule there is no answer to the question.

The desired result can be attained by pouring the water containing the cleared diatoms into a glass bowl and letting it stand until the diatoms have settled and all eddies have died out in the liquid. By inclining the bowl sideways and giving it a gentle rocking motion a quantity of flocculent matter will be detached and can easily be made to roll up into small lumps and drawn away from the diatoms, when the lumps can be sucked up with a glass syringe. The process can be repeated over and over again till nothing but pure diatoms are left. The necessary rolling action is caused by viscosity, and except at the surface of the bowl the small oscillations of the fluid are practically irrotational. The diatoms mostly collect at the edge of the receding liquid, but it is important that the operation should be performed in the shade, as otherwise "greasiness" is produced by the evolution of air, and the diatoms float and stick on the surface of the water.

When all the flocculent matter is removed the fluid is stirred up by the syringe and then sucked up and deposited on the cover-glass, when the diatoms will be found to be perfectly evenly distributed, and the cover-glass must be left untouched and protected from dust until the water has dried. It is almost impossible to avoid impurities being deposited round the edge of the cover-glass, and it is my practice to wipe off a narrow margin, the central part being clean. The method of cleaning answers equally well for the desmids found in the sphagnum pools in North Wales.

I have collected diatoms from very unpromising localities by washing a quantity of seaweed in a large basin and emptying the basin by suddenly reversing it and immediately restoring it. The tiny pool of water left in the basin is usually full of diatoms, and if slowly drained off sand will be left behind.

G. H Bryan.

Plâs Gwyn, Bangor,
Carnarvonshire.

American Official Publications.

I beg leave to direct attention to the lack of facility for obtaining the official scientific publications of the various departments of the United States Government. If it is desired to obtain a copy of one of these, it is necessary to write to Washington, enclosing the anticipated and approximate sum for payment, and in due course the publication arrives. Such a procedure necessitates a delay of about a fortnight at the very least, and the accredited agents of the U.S.A. Government in this country inform me that more than a month may elapse before the information is received.

It is obvious that such delay is annoying and undesirable, the more so because many of these publications are of real value for the careful work they contain. Consultation at a library is not always satisfactory, as the various series may not be complete and are not invariably in a condition suitable for quick reference: in any case, personal possession is usually more satisfactory and is often imperative.

Some time ago I brought this matter before my friend Dr. George M'Lean, who was on a visit from the United States in order to report to his government on the British universities, and afterwards became so valuable as a link between American students and British and French centres of learning. I do not know whether or not he took any action, but, so far as I am aware, the situation remains the same as it always has been.

It would, I consider, be of considerable value for arrangements to be made so that all the U.S.A. official publications could be purchased in Great Britain as soon as they can arrive here after their issue in America. There can be no doubt as to the practical and educational value of such an arrangement, which might include a somewhat widespread distribution, at a nominal fee, of periodic lists of the various Bureaux and Departments.

Percy E. Spielmann.

The Athenæum,
Pall Mall, London, S.W.1,
March 24.

The Use of an Artificial Horizon in Photographic Measurements of Buildings or other Structures.

In a letter in Nature for March 6, p. 338, Mr. Mallock records his method of using an artificial horizon in photographic measurements of buildings. The method, as described, would of course give a permanent and easily studied record, but it appears to the present writer as needlessly complex. No mention is made by Mr. Mallock of a modern phototheodolite which, set up and in adjustment, would give, without the need for an artificial horizon, all the information required. The setting up, usually by means of an attached bubble, introduces into the instrument the desired vertical. The correlation of this vertical with the image on the photographic plate is a practical matter of 'check' or 'adjustment' on the instrument itself. This 'setting up' or levelling of the camera is essential in the case of any photographic recording instrument for such a purpose. Having thus obtained a true vertical, it appears unnecessary again to secure it by means of an artificial horizon. The method of indicating fundamental directions on the plate would be a matter of choice. It might be a series of fiducial vertical lines or simple marks in the photograph to indicate vertical and horizontal planes. Unless the artificial horizon has merits not fully appreciated by me, it would appear better to carry out such work with a simpler and practically standard equipment.

Mr. Mallock's very interesting letter does, however, suggest the question as to whether periodic photo surveys of our more important public buildings might not be part of upkeep routine. The survey need not be expensive and the records could be studied at leisure. Photographic surveys at ten-yearly periods, or as required, would be a safeguard against unsuspected subsidence or other changes.

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Did Davy melt Ice by Friction in a Vacuum?

Quite firmly entrenched in scientific literature, including some very recent English histories of science, is the statement that Sir Humphry Davy contrived a clockwork by which two pieces of ice were rubbed together and made to melt under the exhausted receiver of an air-pump. This is incorrect. A reference to Davy's works (Davy, "Collected Works," vol 2, 1839, p. 11, 12, "Experiment II." and "Experiment III.") indicates that in one experiment he melted ice at 29° F., by friction, *in the open*, and that in another experiment he caused *wax* to melt by friction of two metals (wheel and plate) *in a vacuum*. Davy did not melt ice by rubbing together pieces of ice in a vacuum.

Florian Cajori.

University of California.

Tests of Relativity Theory.[1]

By Prof. A. S. EVE, C.B.E., F.R.S., McGill University, Montreal.

> *"They say miracles are past; and we have our philosophical persons, to make modern and familiar, things supernatural and causeless. Hence it is that we make trifles of terrors, ensconcing ourselves into seeming knowledge, when we should submit ourselves to an unknown fear."*—SHAKESPEARE ("All's Well that Ends Well").

THOSE who were fortunate enough to attend the meeting of the American Physical Society at Kansas City in January, found ample food for reflection on the strange but interesting position into which the experimental tests of the consequences of the theory of relativity have now passed.

This theory, first received with reluctance, is now held with extreme tenacity. In some form or other, it has come to stay. It can be modified, but not annihilated. It may, indeed, fall into line with evolution which every one believes, few can define, and no one can "explain." Its disproof has become a far more formidable task than its proof.

Those, however, who carry relativistic ideas beyond their proper sphere of mathematical physics will do well to ponder the intensive limerick of Father Ronald Knox—

"There was a young man who said God
Must think it excessively odd
That the sycamore tree
Just ceases to be
When there's no one about in the Quad."

But surely we are wandering from Kansas!

What then are the experimental tests to which the theory or theories of relativity may be subjected? Mainly five:

(1) The gradual shift of the perihelion of Mercury stated to be 41″ per century and found by Einstein to be 43″. Here, as elsewhere, no sooner is the calculated found to agree with the observed value, than the latter becomes elusive and fresh calculation gives widely differing numbers, 38″ or even 29″, so that Einstein has to build not on a rock but on a quicksand.

(2) The bending of the rays of light passing near the sun's surface, verifiable only at time of total eclipse. This story is too well known to be retold. British and also, especially, American astronomers are well satisfied that the verification is amply complete; but there are many astronomers and physicists who are well aware that this verified effect may be assigned to a number of other causes, particularly to refraction.

(3) At Kansas City, Dr. St. John gave a most complete account of his exhaustive inquiry into the shift towards the red in the spectrum of the sun, a shift to which Einstein attached so much importance that he is reported to have said that if the shift did not exist, then his theory of relativity was wrong. This statement is not upheld by Silberstein, who in his exquisite treatise on "The Theory of Relativity" (p. 392) points out that the period of an atom on the sun need not necessarily be the same as the corresponding period of a similar atom on the earth, as is commonly assumed. The full relation is

$$\lambda_{\text{sun}}/\lambda_{\text{earth}} = \left(1 + \frac{M}{c^2R}\right)\tau_{\text{sun}}/\tau_{\text{earth}},$$

where λ is the wave-length corresponding to period τ ($\lambda = c\tau$, of course), M is the mass, R the radius of the sun, and c as usual the velocity of light. Einstein assumes $\tau_{\text{sun}} = \tau_{\text{earth}}$ (but it need not be so),[2] and in that case $\lambda_{\text{sun}}/\lambda_{\text{earth}} = 1 + \frac{1{\cdot}75}{8 \times 10^5}$, so that $d\lambda/\lambda = 2{\cdot}11 \times 10^{-6}$, amounting to 0·008 of an Ångström unit in the blue.

This shift is certified by St. John and by Evershed to be true for the sun. Incidentally the testing of this relation has stimulated an enormous amount of research into the character and motion of the sun's atmosphere. In addition to the horizontal motions due to the sun's rotation and other causes, there are vertical motions varying with elevation, each producing its baffling Doppler effect overlapping the Einstein shift. Strangely enough, the pressure shift can be ignored, for it is estimated, even at the very base near the photosphere, that the pressure of this flaming atmosphere fourteen thousand kilometres thick is but one-tenth of our atmosphere!

Where calcium is first ionised the pressure is but one ten-thousandth, and passing upwards through the regions of the sodium D lines on to the H_α and H_β, we arrive near the top to a pressure of 10^{-13} earth's atmosphere where Ca^+ exists, and the calcium atom enjoys the privilege of losing a second electron.

The full evidence, standing by itself, would testify as much to the skill of the astronomers as to the accuracy of the theory, without any reflection on their transcendent honesty of purpose.

But the real treat of the meeting was yet to come. St. John threw on the screen a photograph of the spectra of Sirius and of its illustrious companion, the White Dwarf. The consequent applause of a large audience told its own tale. The spectrum of the companion was bordered on each side by the scattered light of Sirius. On the right at the red end the companion's spectrum was conspicuously clear; at the other end the blue of Sirius largely overwhelmed it. The predicted shift in this case is 34 times that in the sun, amounting to 21 km./sec., while the measured shift gave for H_β, 26 km./sec.; for H_γ, 21 km./sec.; for other lines, 22 km./sec.—mean, 23 km./sec. Here was indeed an unmistakable and emphatic triumph for Einstein of undoubted and overwhelming importance. Shall we not also pay a tribute to the genius of Eddington, who foresaw the possibility of a gaseous star of atoms completely stripped, and therefore giving rise to little radiation pressure, resulting in a compactness hitherto unconceived, amounting to a density fifty thousand times that of water?

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[1] From a lecture given to the Physical Society of McGill University, Montreal, January 1926.

[2] This is the answer to Sir Oliver Lodge's recent letter to NATURE (December 26, 1925, p. 938).

(4) At a joint meeting with the American Association for the Advancement of Science (a close relative of the British Association in type and design), the American Physical Society had the pleasure at Kansas of hearing their illustrious president, D. C. Miller, give a clear and interesting account of his latest results on the famous Michelson-Morley-Miller experiment as carried out by him on Mount Wilson. He has, in 1925, carried out a long series of continuous experiments which exceed in quantity and weight all previous experiments of this type He has taken every precaution of which the most careful of physicists is capable; he has listened and given heed to the suggestions of critical friends, for he is a man without enemies. He has kept aloof from preconceptions and refused to be dragged into controversy. *He proclaims definitely a positive result indicating an earth motion through space of 10 km./sec.* The direction of motion is 6° from the south pole of the solar system, as if our system was like a falling leaf moving broadside on to its proper motion. It will be recollected that in 1887 Michelson and Morley obtained a displacement of 0·02 of an interference fringe, whereas the stagnant ether theory indicated that $2v^2L/c^2\lambda$ should give 0·4 of the said fringe. This was *assumed* to be a null effect.

In 1905 Morley and Miller at Cleveland obtained 0·0075 out of 1·5. Then followed the Rayleigh and Bruce double refraction experiment, the Trouton and Noble capacity experiment, the Fitzgerald and Lorentz shortening theory, and ultimately the special and generalised theories of relativity of Einstein.

Now, mixing metaphors, we see the very experiment, which first started the ball a-rolling, turning round to bite the hand which fed it. Yet we seek intuitively, and therefore possibly wrongfully, for some explanation of Miller's result other than the abandonment of the theory of relativity. Why? Because other experiments are in favour of it? Partly, no doubt. Chiefly, I think, because the space contraction and time elongation of Einstein make the Maxwell equations transformable, and because the change of mass with speed, well verified for β-rays, agree with a rational outlook on a universe where we find only electrical phenomena exhibited as energy in a metrical space-time. Minkowski's work is as persuasive as a great experiment. But the matter will not rest here, for already American physicists are contemplating more experiments at different levels and localities. Rumour has it that Millikan has in hand a portable apparatus. Critics have pointed out that 10 km./sec. a second on Mount Wilson and zero at sea-level would perturb the agreement of astronomical data from various observatories. But Miller has never suggested zero at sea-level, and observatories do have 'personal equations' no less than individual observers. The situation is one requiring patience and experiment rather than speculation at present.

Miller has, however, taken a further step which is quite independent of the positive result of 10 km./sec. above stated, and no less of his deduced direction of motion. He finds that he can get a satisfactory explanation of all his results if he assumes that the solar system is moving with a velocity of 200 kilometres a second (*or more, not less*), relative to the ether. If that is so, then the earth must *drag* 95 per cent. of the ether with it and 5 per cent. must *slip* past the earth. Here we have a revival of the ideas of Stokes, with possibly Planck's addition of immense compressibility due possibly to gravitation. To the writer this idea suggests profound difficulty. For example, the ether would have a vastly larger condensation round the sun than round the earth. However that may be, it appears true that if Miller's results are confirmed at different places, then all our theories go into the melting-pot, relativity and all, and a patient resurvey must commence to unravel afresh order from chaos. The only grave mistake which we can make at present is to treat Miller's main results otherwise than seriously.

(5) It is a relief to pass from the profound difficulties of the second-order experiments to the conspicuous success of the great first-order effect devised by Michelson, advocated strenuously by Silberstein, and carried out so efficiently by Gale and his co-workers. The results of the famous Chicago rotation experiment are equally explainable by the old view of a stagnant ether, or by the Einstein relativity theory. It is no less opposed to the Stokes drag theory, or to Miller's suggestion of 10 km./sec. slip and 190, or more, km./sec. drag. The compromise of Silberstein that in rotation there is full drag, and that in translation there is a partial drag, will suit the experimental evidence in hand, but no one seriously supposes that such will be the ultimate result of further experiments.

At the meeting at Kansas, in the unavoidable absence of Gale, a graphic account of the Chicago experiment was given by Watson, who was himself engaged in the work. His description dealt with the body rather than the soul of it.

If two runners start back to back and run with equal speeds in opposite directions round a circular track, they will pass each other again at the starting-point. If one runs faster than the other, there will be a difference. So if light is sent round in opposite ways a many-sided polygon approximating to a circle of radius r, say at the north pole, there will be a time difference

$$\frac{2\pi r}{c-v}-\frac{2\pi r}{c+v} \text{ or } \frac{4\pi r v}{c^2},$$

and this becomes

$$\frac{4\pi r^2\omega}{c^2},$$

or

$$\text{the area} \times 4\omega/c^2;$$

where r is the radius of the track; v, or ωr, the velocity due to earth's rotation. This circulation of light in opposite ways still depends upon the *area*, whatever the shape of the track round which the divided beams circulate. In latitude l there is a factor $\sin l$ to be introduced, and there results a lag in wave-length of $4 \times \text{area} \times \omega \sin l/c^2\lambda$, with an observed value 0·230, as against a calculated value of 0·236, or a verification within three per cent. In place of the crude proof above, there is the relativity proof in Silberstein's "Theory of Relativity" (p. 382), and other proofs may readily be derived, for it is hard to arrive at any other result by any first-order principle. The result of the experiment is equally gratifying to the relativist and to the classicist. It was pointed out to the writer by K. T. Compton that this uncertainty of 3 per cent. might cover the failure to detect the 5 per cent. slip (20 out of 200 km./sec. or more) which Miller's result might suggest.

As Watson described this heroic experiment, a feeling of disappointment arose that such glorious apparatus had to be dismantled. The pipes (14 in.) were well and truly laid over a large area, and it was necessary to make good joints to get a vacuum, but winter was coming on and frost would have displaced the pipes, so that it is a greater matter for congratulation that this fine experiment should have been carried out, than that the apparatus should have been dismantled and removed.

It is possible to summarise the situation:

For Relativity.	*Against Relativity, but for drag and slip.*
Mercury perihelion (?). Eclipse results. Spectrum shift.	Miller's experiments on Mount Wilson.
For Relativity or for Stagnant Ether, but against drag and slip. Michelson-Gale-Silberstein. Chicago rotation experiment.	

This brief and imperfect record of a difficult subject is written for those who are interested in the situation as it appeared to one who attended the meetings at Kansas City.

Some Properties of the Vitamins.

THE reality of the existence of the three well-known vitamins having been confirmed by numerous careful investigations, attention was directed to their isolation in a pure state, with the ultimate aim of discovering their chemical constitution. At first the work was largely qualitative, but with improvement in the technique of the necessary animal experiments, quantitative investigations became possible, and have led not only to a great increase in our knowledge of these elusive substances, but also to the probable discovery of further members of the series. Whilst undue multiplication of the number of unknown accessory food factors must be deprecated, yet it must be admitted that recent work suggests that there exist besides the orthodox trinity, an antirachitic factor D and an antisterility vitamin E: at the same time, our knowledge of their chemical properties has advanced so considerably, especially in the case of the fat-soluble vitamins A and D, that some of them may soon be justifiably transferred to a place amongst compounds of a similar chemical constitution. Thus the multiplication of vitamins resolves itself into the problem of the identification of substances which are required in metabolism only in minute amounts, and the discovery of which has been delayed until recently owing to difficulties of chemical analysis, and to the fact that they are usually present in the natural food of animals in adequate amount. Similar problems can be found in other branches of biochemistry and metabolism: thus all the amino-acids which make up the protein molecule have not yet probably been isolated, and vitamins are not the only substances which are required in minute quantities—for example, certain elements such as iodine.

Recent investigation has made it clear that the fat-soluble vitamins are present in the unsaponifiable portion of the fat, and that cholesterol can be removed from this fraction without impairing its efficacy. Takahashi and his co-workers have now carried our knowledge a stage further in an elaborate investigation (K. Takahashi, Z. Nakamiya, K. Kawakami, and T. Kitasato, *Scient. Papers, Inst. Phys. and Chem. Res., Tokyo,* 1925, vol. 3, p. 81). Starting with cod-liver oil or green leaves, the unsaponifiable fraction was obtained in a fairly pure condition and the cholesterol removed; some further purification of the product isolated from the former source was attempted by crystallisation from acetone at −60° to −70° C., followed by distillation at 147°-150° C. under 0·02-0·03 mm. pressure. These drastic treatments did not appear to destroy the vitamin, but did not effect any great purification: the products obtained from the two sources are somewhat different in composition, that from the oil being the more unsaturated. The yields of the crude material were of the order of 0·1 per cent of the oil and 0·025 per cent of the dried leaves. Tested on animals (rats), about 0·04 mgm. of the crude material or 0·005 mgm. of the purified product sufficed, when given daily to each animal, to promote growth on a diet deficient only in vitamin A.

The Japanese investigators have made a lengthy investigation into the physical and chemical properties of their refined product, which they have labelled 'Biosterin.' It has an absorption band in the ultra-violet, it is soluble in the organic solvents, but is unstable in ether and chloroform, and it is adsorbed by fuller's earth and animal charcoal. It also produces a photo-chemical action upon photographic plates, which the authors suggest, as the result of a series of experiments, is due to the formation of active oxygen from the oxygen of the air over the material: a similar effect was found to be produced, though less markedly, by the cod-liver oil itself, and also, but very feebly, by olive oil. As mentioned above, the vitamin is also stable to heat, in the absence of air. O. Rosenheim and J. C. Drummond (*Biochem. Journ.*, 1925, vol. 19, p. 753) have also shown that the cholesterol free unsaponifiable fraction of cod-liver oil containing the vitamin can be distilled in superheated steam in an atmosphere of nitrogen or in a high vacuum without loss of activity. On the other hand, H. W. Southgate (*ibid.*, p. 733) has found that when the cod-liver oil itself is heated to 200° C. in an atmosphere of carbon dioxide, and maintained at this temperature for varying lengths of time, a slow destruction of both the growth-promoting and the antirachitic factors takes place: the author was unable to show that this destruction was due to the liberation of fatty acids by hydrolysis at the high temperature used.

The stability to heat of these vitamins is of considerable practical importance: thus they are likely to be found in certain foods, such as milk, which has been dried by means of heat. Gladys A. Hartwell (*Brit. Med. Journ.*, 1925, vol. 1, p. 1073) has shown that both dried and evaporated milks form, together with white bread, diets adequate for growth and reproduction in rats: the former was as good as, or better than, fresh cow's milk, whilst the latter was distinctly inferior, this inferiority showing itself more especially when the animals reached adult size. It is possible that this difference is due to a relative deficiency of vitamin B in the evaporated milk. It must be pointed out that these results do not imply an adequate supply of vitamin C, since the rat requires extremely little of this vitamin compared to the guinea-pig or man: moreover, vitamin C is the most sensitive to the ordinary destructive agents. Katharine H. Coward (*Biochem. Journ.*, 1925, vol. 19, p. 500) has found also that drying green leaves need not destroy vitamin A, though it appears to vanish in leaves which are allowed to wither. The importance of the vitamin content of milk appears again in some recent experiments by H. Pringle (*Sci. Proc. Roy. Dub. Soc.*, 1925, vol. 18, p. 93). Human milk was found to be less efficient in promoting the growth of young rats than cow's milk, probably owing to a deficiency in vitamin B content. Thus again is the importance of the mother's diet during pregnancy and lactation emphasised.

Takahashi and his co-workers have carried out a number of analyses of the purified products obtained from cod-liver oil and green leaves, and suggest that their formulæ should be $C_{27}H_{44}O_2$ and $C_{27}H_{46}O_2$ respectively: for comparison, that of cholesterol, $C_{27}H_{46}O$, may also be given. A large series of chemical derivatives have been prepared, from which the authors have deduced that the oxygen atoms are present as OH groups, one a tertiary, and the other a primary or secondary alcohol, and that the products are unsaturated, containing three double bonds: they are also capable of reduction, and form a digitonide but less readily than cholesterol: on standing they slowly take up oxygen. In general, it may be stated that any change in the molecule results in a loss of the growth-promoting property. Cholesterol and its oxy derivative, which has the same formula as the product obtained from green leaves, are also inactive.

At the present time the most useful chemical property of vitamin A is probably that of producing a blue colour in the presence of certain reagents. Takahashi has investigated this side of the subject, using a number of different reagents, such as sulphuric acid and fuller's earth: inactive allied products give a reddish colour under similar conditions. Rosenheim and Drummond have utilised arsenic chloride, trichloracetic acid, dimethylsulphate, etc., for a similar purpose, and have found that the intensity of the blue colour runs parallel with the product's potency when tested on animals, in the case of both butter and cod-liver oil. Incidentally it may be mentioned that the antirachitic factor, in the form of cholesterol activated by exposure to ultraviolet light, does not give any colour with these reagents, a further confirmation of the distinctness of vitamins A and D. The test is very delicate, the cholesterol free unsaponifiable fraction giving it in a dilution of one in two million. The colour is discharged by a number of substances, including alcohol and ether.

One point may be referred to before leaving the work of the Japanese investigators, and that is that they have found their products toxic to rats in doses of about 10 mgm. a day. The possibility that this might be due to some poisonous impurity, perhaps introduced during the requisite chemical manipulations, does not appear to have been considered. It is obvious that the value of their conclusions will be considerably enhanced when the work has been repeated—and confirmed—by independent observers.

The relation of light to the fat-soluble vitamins has not yet been completely elucidated, but it appears from the evidence available that it produces synthesis of both the growth-promoting and antirachitic factors in plants, but in animals only influences the latter. Plants grown in the dark produce no vitamin A, but even one day's exposure to light is sufficient to cause its appearance: at the same time the lipochrome pigments are developed (K. H. Coward, *ibid.*). The relation of ultra-violet light to the antirachitic factor in plants has been little studied, since both factors usually appear to occur together: in animals, light does not cause any synthesis of vitamin A, but may influence the production of the antirachitic factor, for example, by activating the cholesterol in the skin. Whether this is the case or not, the improvement in calcification in rickets is probably in part due to an increased calcium absorption; since in other conditions in which there is a drain on the calcium of the body, for example, in lactation, exposure of the animal to ultra-violet light results in increased calcium absorption and retention (see the experiments on goats by J. B. Orr, H. E. Magee, and J. M. Henderson, *Biochem. Journ.*, 1925, vol. 19, p. 569).

A further factor to be considered in this increased retention of calcium is the influence of small quantities of iodine in the diet. F. C. Kelly (*ibid.*, p. 559) has shown that this addition to the diet of the growing pig produces an increased retention of nitrogen, phosphorus, and calcium, and points out that cod-liver oil is a rich source of this element. Iodine is necessary for the production of the thyroid hormone, which is itself essential for growth, but the relation, if any, between this secretion and the growth vitamins is at present unknown.

Whether light has any influence on the other vitamins is at present doubtful. In fact, so far as vitamin C is concerned, P. Eggleton and L. T. Harris (*Brit. Med. Journ.*, 1925, vol. 2, p. 989) have recently shown that oats germinated in the dark produce the vitamin in proportion to the amount of growth occurring; moreover, ultra-violet light cannot prevent or cure experimental scurvy in guinea-pigs on a scorbutic diet. Hence it cannot replace an adequate supply of this vitamin in the food.

Less is known of the chemical nature of the water-soluble vitamins than of that of the fat-soluble. S. S. Zilva (*Biochem. Journ.*, 1925, vol. 19, p. 589) has obtained vitamin C in a concentrated condition from orange and swede juice. The nitrogen content of this fraction was only 1-2 mgm. per cent., of which about half was amino and amide nitrogen; the latter could be destroyed without interference with the potency of the preparation. R. A. Peters (*ibid.*, 1924, vol. 18, p. 858) has obtained a somewhat similar result with a concentrated solution of vitamin B extracted from yeast; nitrous acid does not destroy it, as is the case with primary and many secondary amines. Working with H. W. Kinnersley, he has succeeded in purifying the yeast extract still further, until only 0·084 mgm. is necessary to cure symptoms of polyneuritis in a pigeon (*ibid.*, 1925, vol. 19, p. 820). Regular doses given to a bird on a polished rice diet are capable of preventing the appearance of symptoms without, however, maintaining its weight. Now vitamin B is essential for growth and maintenance of weight in rats, so that the authors are led by their results to suggest that the factor which cures and prevents polyneuritis in pigeons may be different from the one which is necessary for growth and maintenance of weight. It is possible, however, that the continued loss of weight without symptoms may be due to the deficiency of the polished rice diet in some other material.

It has been known for some time that excessive amounts of carbohydrate food hasten the onset of symptoms in pigeons. In examining the relationship between vitamin B and carbohydrate metabolism, P. Eggleton and L. Gross (*ibid.*, 1925, vol. 19, p. 633) have found that deprivation of vitamin B in rats leads in about a month to a fall in the blood-sugar, together with a gradual disappearance of glycogen from the liver; at the same time Kinnersley and Peters noticed that the convulsions of polyneuritic pigeons occurred at low temperatures, whilst removal of the birds to the warmth of the laboratory produced a temporary improvement. Now it is known that in mice the convulsions produced by insulin only occur regularly if the animals are kept at an external temperature so high as 37° C. At first sight the two observations appear opposed; but the condition of the experimental animals is fundamentally different: the mice have glycogen in their livers, whilst the pigeons probably do not. Hence cold in the former, stimulating glycogenolysis, acts against the insulin injected by producing a flow of sugar into the blood and thus prevents hypoglycæmic symptoms, whilst in the latter this cannot occur owing to the paucity of glycogen in the liver. At the same time, the cold increases the metabolism of the muscles, leading to withdrawal of sugar from the blood, which cannot be replaced, thus producing convulsions: warmth would diminish the demand for sugar and allow the blood-sugar to be restored to a more normal level. Some such hypothesis may be useful in correlating the various observations which have been recorded.

In conclusion, attention may be directed to some recent work in connexion with vitamin E, first described by Evans and Bishop a few years ago. It was observed that rats on certain synthetic diets, chiefly those in which the protein was supplied by casein, became sterile in course of time: any offspring of these rats obtained before sterility occurred were sterile from birth. In the female the ovaries are normal, the sterility being shown by absorption of the embryos late in gestation. In the male, on the other hand, the sterility is produced by degeneration of the testes themselves: a full description of the histological changes involved has been given by K. E. Mason (*Proc. Nat. Acad. Sci.*, *U.S.A.*, 1925, vol. 11, p. 377). Degeneration begins about two months after the commencement of the diet, and recovery only occurs when the vitamin is given if some normal testicular tissue is still in existence.

The distribution of the vitamin E and its properties are considered in more detail by H. M. Evans and G. O. Burr (*ibid.*, 1925, vol. 11, pp. 334 and 378). It is fat soluble, and its richest source is the oil expressed from the germ of wheat: it occurs also in oats, corn, lettuce, alfalfa, etc.; in small amounts in animal tissues including milk, and also in moderate amount in the vegetable oils. Cod-liver oil contains little. It is very stable and can be distilled in superheated steam; it occurs in the unsaponifiable fraction of the oil, but is not precipitated by digitonin: it does not contain nitrogen, sulphur, phosphorus, or the halogens. A single dose of 5 mgm. of the concentrated product by mouth or subcutaneously to a female rat suffices for the production of a normal litter, whilst 0·3 mgm. daily prevents male sterility. It appears to be stored in the body to a considerable extent, but is used up in the ordinary processes of metabolism quite apart from pregnancy. In some of its properties, therefore, it resembles the other fat soluble vitamins, but in its distribution, and in the fact that normal growth occurs in its absence, it is sharply differentiated from them.

News and Views.

AT a conference on March 25, held by the principal broadcasting organisations, representatives from twenty European countries took part. A new scheme for the redistribution of wave-lengths in Europe was submitted and provisionally approved. The details of the scheme will now be considered by the various interested organisations from the point of view of local difficulties. Suggested amendments will be considered by the Committee of the Office International of Radiophonie, and a final scheme will be drawn up for the approval of the various Governments concerned. The scheme divides broadcasting stations into two classes. The first class consists of those capable of guaranteeing good reception at long ranges. They receive an 'exclusive' wave-length, but every country receives at least one exclusive wave-length. The other class consists of low-power stations for the use of local listeners only. All this class will work on a common wave-length. Experiments have shown that each of these small stations can work without practical interference from the other stations using the same wave-length. To ensure satisfactory results it is absolutely necessary that the same standard type of wave-metre should be used by all the stations. This problem is being considered by a technical committee at Brussels under M. Raymond Braillard. No wave-lengths less than 200 metres have been allotted, and great pains have been taken to avoid unnecessary changes in wave-lengths already in use. It will be seen that the proposed solution is, perhaps unavoidably, not a perfect one. The ideal solution would be one in which every listener with a good valve set would be able to listen in to many of the small stations in Europe. If they all have a common wave-length this would be impossible In the course of other meetings held at Geneva, committees were formed to consider pressing international broadcasting problems with the object of finding practical solutions.

THE Czeckoslovak Academy of Agriculture, of comparatively recent formation, is seeking to establish and consolidate international relations for the benefit of agriculture in its country. The latest number of the *Věstník* (Ročnik I., Čislo 9-10) gives reports of papers read at the general meeting of the Academy, with summaries in French, German or English. The address of Dr. Julian Stoklasa on the nitrogen problem in the Czeckoslovak republic is given in four languages, rendering it accessible to a wide circle of readers. The problem is acute, but is receiving much careful attention. The yearly consumption of nitrogen is only 2·5 kilogm. per hectare compared with 20 kilogm. per hectare in Germany, and it is calculated that very heavy losses have been incurred during the last seven years owing to this deficiency, as the yearly harvest is held to abstract 40 kilogm. nitrogen from each hectare of soil, on an average. The production of synthetic nitrogenous manures on a large scale is under careful consideration. Since 1923 the work has been under the direction of the Ministries of National Defence, Public Works and Agriculture, which created the Inter-ministerial Nitrogen Committee. It is recognised that the country is too dependent on imported food stuffs owing to the failure of agriculture to attain the necessary economic intensity. The chief causes of failure are the high costs and the scarcity of certain means of production, nitrogenous fertilisers being a prominent example, more than 60,000,000 kilogm having recently been imported yearly, chiefly as Chile saltpetre. As a further means for improving the knowledge and status of agriculture in Czeckoslovakia, the Academy has set up commissions for publishing an agricultural encyclopædia and a bibliography, and for the establishment of a central library and reading-room in which would be concentrated all Czeckoslovak and Slavonic agricultural literature, together with the most important world literature on the subject.

ONE cannot imagine a more eloquent series of tributes than those which, lead by M. Painlevé, were pronounced over the grave of the late Camille Flammarion, which have now been issued in permanent form, admirably reprinted on art paper, from *L'Astronomie*, the bulletin of the Astronomical Society of France, of which Flammarion was the founder. The book also contains an account of the funeral ceremonies, and a selection from thousands of letters received from astronomical observatories and scientific institutions at home and abroad, and from public and private individuals. A lengthy and complete discourse on the life and work of Flammarion is included from the facile pen of M. Emile Touchet, who was long associated with the dead "maître" in the administration of the largest of all astronomical societies. Several portraits of Flammarion at various periods of his life are included, the last of which, taken shortly before death, is a characteristic picture. For an authentic pronouncement on the life and work of an inspiring French astronomer, one need not go past this little publication, coming as it does from the fount of his astronomical activity. The book can be obtained from the headquarters of the Society at 28 Rue Serpente, Paris. Flammarion was a great admirer and user of British scientific publications, particularly NATURE, and it is interesting to learn on the authority of his widow that the last piece of literary work he accomplished, actually on the day of his death, was the translation of a note on "Ancient Clepsydræ" from our issue of October 25, 1924. This he intended for reproduction in *L'Astronomie*. Shortly after this was completed he walked to the window, commented upon the beautiful day and the loveliness of his garden, and collapsed into the arms of Madame Flammarion. The last prospect he beheld was the extensive view over the Seine which he asked the writer of this paragraph to photograph for him one magnificent summer Sunday afternoon many years ago. Flammarion was proud of that view.

AT a meeting of the Scientific, Technical, and Trade Circle of the Institute of Journalists, held on March 30, a summary of the aims and objects of the Optical Convention was given by Mr. F. Twyman (chairman of the Executive Committee), Sir Richard Paget (Hon. Treasurer), and Prof. Cheshire. In thus inviting the co-operation of the members of the Circle the precedent set in connexion with the British Empire Exhibition a couple of years ago was followed. Mr. Twyman enumerated some of the very wide range of instruments and apparatus in which optical lenses and prisms are necessary, and Prof. Cheshire, who gave an account of some of his experiences when acting as Director of Optical Munitions during the War, directed attention to the vital importance of an adequate home supply of optical glass in modern warfare, and the necessity of encouraging and developing the British optical industry in time of peace. Sir Richard Paget gave an entertaining account of the various optical illusions and exhibits at the Convention likely to be of popular interest. These include many ingenious and novel devices as well as demonstrations of lantern projection in natural colours and other processes of great practical importance. In this respect the organisers are following the lead of early pioneers in science who did not disdain to kindle public interest by the exhibition of odd contrivances and striking effects. In early scientific entertainments 'optical illusions' often played a considerable part.

"CAPE to Cairo," Major C. Court Treatt's kinematograph film of a journey by motor car through Africa from south to north, now showing at the Regent Street Polytechnic, is a record of a remarkable feat of organisation and endurance. The expedition, with Major Treatt as leader, consisted of Mrs. Treatt, Mr. F C. Law, Mr. Errol Hinds, and Mr. T. A. Glover, the photographer who accompanied Major Angus Buchanan in his journey across the Sahara A distance of 13,000 miles was covered in sixteen months; but a mere statement of time and distance can convey no adequate conception of what the journey involved. In the early stages, while traversing Rhodesia, they were caught by the rains. The cars were constantly bogged in the deep mud of the roads, while the rivers were so swollen as to be almost impassable. Throughout, the rivers were the most serious obstacle. When they reached the Nile, it was only by towing the cars across the river under water that the expedition was saved from failure. The film records some native dances—a war dance in a Uganda village and a Dinka dance being particularly interesting—and gives a good idea of the varying types of African scenery. Special mention must be made of the pictures of a herd of buffaloes and a really remarkable and exceptional series of the Zambesi falls. The part played by Mrs. Treatt in securing friendly relations with the natives is an object lesson of the valuable work which can be accomplished by a woman, and in some matters by a woman only, in anthropological and geographical exploration.

In the course of an account of recent excavations at Beisan in Palestine, contributed to the *Times* of April 4 by Mr. Allan Rowe, Field Director of the Philadelphia University Museum Expedition, reference is made to an interesting find, and a suggestion made as to its meaning and use, which will appeal to all readers of Sir James Frazer's "Golden Bough." The object in question is a hollow circular ring of clay, to the top of which are attached several jars and animal heads. The jars have holes in the base which connect with the hollow inside the ring. Another example such as this was found some years ago at Megiddol and a derivative, much later in date, was found at Naukratis in the temple of Aphrodite. It is suggested that these objects are the flower stands known to have been in use in Syrian temples, and that they may be the actual "Gardens of Adonis," the baskets or pots in which various kinds of seeds or grain were planted and tended by women for a period of eight days, when they were thrown into a river or stream with an image of the god. It will be remembered that Sir James Frazer, in his "Adonis, Attis and Osiris," suggests that the rite was intended as a charm to secure abundance of rain or water for the crops, and adduces a number of analogous customs from various parts of the world to support his view.

For several years past an annual inter-university conference of metallurgical students has been held, attended by delegates from the principal universities and technical colleges in Great Britain, for the purpose of discussing questions concerning the training and prospects of professional metallurgists. At the conference held in Birmingham on February 19 and 20 last, the subject for discussion was the place of the metallurgical student in industry. There was general agreement among the speakers as to the necessity of combining works training with the academic course, for which purpose the vacations could be partly utilised. Graduates on entering a works should at once be given a self-supporting wage, the system of apprenticeship being undesirable. On the other hand, the graduate should enter on his duties with a due sense of his inexperience and a proper respect for the practical knowledge of the technical man. It was considered that a trained metallurgist should not become a routine chemist, but should be regarded as having a special function. Some speakers urged the giving of more attention to the commercial side of industry, and to such subjects as works organisation and management, instruction in those subjects being given preferably by industrialists. Copies of the report may be obtained free on application to Mr. W. L. Kent, Metallurgical Society of the University, Birmingham.

The Association of Special Libraries and Information Bureaux, which held a conference at Oxford last autumn (Nature, October 10 and November 14), has now decided to proceed with a formal constitution and the enrolment of members. The inaugural meeting was held at the Institution of Mechanical Engineers on March 29 and was well attended. Mr. J. G. Pearce, director of the British Cast Iron Research Association, presided. The Association has planned a third conference, to be held at Balliol College, Oxford, on September 24-27, at which the draft constitution will be submitted to the members. The first work of the Association, which is one of some magnitude, is the preparation of a Directory of Special Libraries and Information Bureaux in the United Kingdom, which should contain in a suitably classified form a guide to existing sources of reference. The Carnegie United Kingdom Trust, which has already generously supported the Association, has promised to finance the preparation of the Directory at an estimated cost of 2000*l*., and with the wide interest already taken in the Association by delegates from learned societies and large industrial corporations, it is hoped that the difficulties of editing such a volume can be overcome.

The King has approved that the Royal Commission on Agriculture in India should be composed of the following: The Most Hon. the Marquess of Linlithgow (chairman); Mr. H. Calvert; Prof. N. Gangulee, professor of agriculture and rural economy, University of Calcutta; Dr. L. K. Hyder, professor of economics, University of Aligarh; Mr. B. S. Kamat; Sir Henry Staveley Lawrence; Sir James MacKenna; Sir Thomas Middleton; The Rajah of Parlakimedi; Sir Ganga Ram. The appointment of a Royal Commission, "generally to examine and report on the present conditions of agricultural and rural economy in British India," was announced by Lord Reading at the opening of the Indian Legislature on January 20. The terms of reference go on to point out particular directions in which investigations are to be pursued. The scope of the inquiry was discussed in these columns in our issue of January 30, p. 166.

Among the gifts for scientific purposes made by the late Prince Albert of Monaco in his will was a sum of a million francs to the Paris Academy of Sciences for the provision of a biennial prize (Nature, October 14, 1922, p. 524). The first award of this prize has been made to Dr. Charcot, who will thus be enabled to improve the scientific equipment of his vessel, the *Pourquoi Pas*! It is appropriate that the first to benefit under the bequest should be Dr. Charcot, for Prince Albert, himself a keen scientific worker, carried out many notable investigations in physical and biological oceanography.

DR. P. CHALMERS MITCHELL, secretary of the Zoological Society of London, will deliver the Huxley Memorial Lecture at the Imperial College of Science and Technology on May 4 at 5 P.M., taking as his subject "Logic and Law in Biology."

THE proceeds of the Daniel-Pidgeon Fund of the Geological Society of London for 1926 have been awarded to Dr. David Williams, who proposes to investigate the geology of the country between Snowdon and the Carnedds.

WE are asked to state that the meeting of the Chemical Society which had been arranged for Thursday, April 15, has been postponed until the usual hour on Thursday, April 22.

THE fifth Hurter and Driffield memorial lecture of the Royal Photographic Society of Great Britain will be delivered on Tuesday, April 20, at 7 o'clock, by M. Charles Fabry. The subject will be "The Photographic Plate as a Measuring Instrument for Visible and Invisible Radiations."

A MEETING of firms interested in the formation of a research association for the paint, colour, and varnish industries will be held at the London Chamber of Commerce, Cannon Street, E.C., on Wednesday, April 14, at 11 A.M. An invitation to be present is given to members of companies interested in these industries.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: A resident tutor in economics in the University of Bristol—The Registrar (April 20). A lecturer in the department of electrical engineering of Bradford Technical College—The Principal (April 21). A lecturer in botany in the University of Bristol—The Registrar (April 30). An assistant plant breeder under the Department of Agriculture and Forests of the Sudan Government—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1 (May 7). A professor of physiology at St. Bartholomew's Hospital Medical College — The Academic Registrar, University of London, South Kensington, S.W.7 (May 20). A laboratory assistant in the Biochemical Department of the Wellcome Physiological Research Laboratories, Beckenham—The Director. A chief physics master at Shrewsbury School—The Headmaster's Secretary, The School House, Shrewsbury.

Our Astronomical Column.

THE DISTRIBUTION OF O-STARS.—An article by B. Gerasimovic, of Charkow Observatory, in *Astr. Nach.* 5420, deals with the galactic distribution of these stars. As is well known, they lie in very low galactic latitude and afford one of the best methods of obtaining the co-ordinates of the galactic plane, and the linear distance of the sun from it. The 144 O-stars in the Draper Catalogue (excluding those in the Magellanic Clouds) give for the galactic pole R.A. 189° 13′, N. Decl. 27° 22′ (equinox not stated, but presumably 1900), while the 78 planetary nebulæ in Curtis's Catalogue give R.A. 192° 13′, N. Decl. 28° 28′. The latter show a greater dispersion than the O-stars, which is shown to arise from wider scattering in space, not from greater proximity to us. The mean distance of the O-stars is taken as 770 parsecs after Wilson (Plaskett increases the distance to 900 parsecs), and the distance of the sun to the north of their mean plane is found to be 31 parsecs.

Further, it is shown that the angular width of the zone of O-stars is greatest in the direction of the anti-centre of the star-system (according to Kapteyn, R.A. $23^h\ 10^m$, N. Decl. 57°), where it amounts to 11°, being only 3° in the opposite direction. This is ascribed to the greater proximity of the zone in the former direction.

THE DISTRIBUTION OF RADIANT ENERGY OVER THE SUN'S DISC.—Bulletin No. 91 of the Aeronautical Institution of the Netherlands is devoted to a communication from the Heliophysical Institute at Utrecht, "The Distribution of the Energy over the Sun's Disc," by W. J. H. Moll, H. C. Burger, and J. van der Bilt. To avoid the disturbing effects of the lower atmosphere the authors set up their apparatus on the Gornergrat near Zermatt. They had the good luck to find next to the hotel a small house with brick walls, admirably suited for an observatory. The 'monochromator' with which the energy of any assigned wave-length was determined was provided with a linear vacuum-thermoelement, and was therefore more sensitive than the apparatus used by previous investigators. The slit of the monochromator was only 0·1 mm. wide. It was found that a sufficiently regular movement of the sun's image, 3 cm. in diameter, past the slit could not be obtained with a cœlostat. Regularity was achieved by using fixed mirrors and giving a steady motion to the lens by which the image was formed.

Final results are not yet available, but the authors claim that they were able to get trustworthy values of the distribution of the energy along about 99 per cent. of the sun's radius against Abbot's 95 per cent. Their values of the ratio of the energy to that at the centre of the disc are greater than Abbot's. The differences attain a maximum amount of about 2·5 per cent. at a distance from the sun's limb of about 8-hundredths of the radius. The discrepancy is attributed to the quicker response of the new apparatus. The general result, that the radiation in all parts of the spectrum falls off rapidly near the limb, is of course confirmed. The effect is most conspicuous in the shorter wave-lengths, so that the sun is yellowish towards the edge. At 5-hundredths of a radius from the limb the blue rays have only half their intensity at the centre and at 2-hundredths less than a quarter. The curves are in fact consistent with the hypothesis that the radiation falls to zero at the limb. It is to be hoped that further use will be made of the observatory on the Gornergrat. Independent measurements of the 'solar constant' might well be made there, for comparison with the determinations at the stations of the Smithsonian Institution in America.

Research Items.

A Tahitian Breast Ornament from Alaska.—Dr. H U. Hall discusses in the issue of the *Museum Journal* dated September last, the provenanoe of an object of exceptional interest recently acquired by the University Museum, Philadelphia. Although it was collected in an Indian village on Admiralty Island, Alaska, it is beyond question a feather breast ornament from Tahiti. Only seven of these are known to be in existence, three being in the British Museum. That they belonged to the highest chiefs is clear, since their adornments include red feathers, sacred to Oro the war god, which could be worn only by persons of this class. They are described by Cook under date September 8, 1777, and possibly, under missionary influence, had ceased to be used so early as 1825, or at any rate not much later. It is therefore improbable that this specimen was carried north by one of the whalers, who did not begin their voyages to the Arctic through Bering Strait until the late 'forties. It would seem most probable that it was taken to Alaska either by Cook or Vancouver, the probabilities favouring the latter. Among the Chilkat it was a clan object and regarded as very precious. It was known as 'raven cape.' The late owner said that the old leaders of her house had boasted of it as a possession which was uncommon It was regarded as the work of the people of another world Fragmentary traditions of its origin connect it with the coming of the white man, and refer it to a strange party who made a visit to the land " in company with the first man of the sun."

An Archæological Collection from Flagstaff, Arizona.—A number of archæological objects from graves found in Young's Cañon, near Flagstaff in Arizona, has recently been added to the U.S. National Museum, Washington. It is of special significance for the archæology of the south-western United States, partly because some of the objects are unique; partly because few antiquities have been obtained from this area. The collection was made by Mr. J. C. Clarke in the course of road-making operations, and consists principally of pottery, red, gray, dark, and painted ware, shell bracelets, armlets, and finger rings, a few bone objects, needles, bodkins, and the like. Two rare specimens of polished bone with incised decoration were evidently ornaments for the hair as they were found on a cranium. Cremation was practised and calcined human bones were found in mortuary vessels or burial urns. Mr. J. W. Fewkes, who describes the collection in *Smithsonian Miscellaneous Collections*, Vol. 77, No. 10, directs attention in particular to the pottery, of which the decorative designs are purely geometric, none showing naturalistic forms of men or animals. None is perforated or ceremonially 'killed.' One object is exceptional, a black and white ware ladle, of which the sides and end of the handle are pinched up to form a cradle. This contains a small clay figurine. Similar figurines have been found higher up the Little Colorado, suggesting that the cradle-handled ladle, though rare, was known in Pueblo households. The pottery as a whole resembles the pre-puebloan of the region north of the Hopi Pueblos—a culture which probably at one time spread over the whole of what is now Arizona and is now best represented on the Lower San Juan in the region called Takonabi.

The Atmosphere and Human Comfort.—The *Monthly Weather Review* for October last has an article on "The Relation of the Atmosphere to Human Comfort," by Dr C. F Brooks of Clark University. The journal also contains other articles on the same subject, treating different branches, but all have general reference to America The work is allied to that undertaken by Prof. Leonard Hill in Great Britain, but an attempt is made to push the study further and to reduce it to mathematical form in order to find a basis by which weather might be classified according to its relation to human comfort. With data of heat emission, heat production, and comfort, Dr. Brooks considers it possible to construct tables which will show for any weather conditions approximately the rate at which a man will cool. We need tables showing for any kind of weather the feeling of cooling which a man will experience under any degree of activity and in any kind of clothing. More calorimetric observations of the actual cooling and heating of man are required. The author hopes that the discussion will be helpful as a pioneering effort.

Asymmetry in Microscopic Organisms.—In his presidential address to the Quekett Microscopical Club (*Journ. Quekett Micr. Club*, Nov. 1925), Mr. D. J. Scourfield directs attention to asymmetry in microscopic organisms and to the need for observations on the functioning of asymmetrical structures in order to throw light on the vexed question of adaptations. Among the rotifers, the Rattulidæ present a twisting of the body so that practically every part is involved in the asymmetry. Among the Bdelloid rotifers the jaws occasionally show slight differences, and in this group there are two ovaries which function alternately, while in other rotifers there is only one ovary. Mr. Scourfield recalls examples of asymmetry in some Crustacea and refers to the occurrence of androgynous individuals of Daphnia, rightly urging the desirability for carefully recording the condition of such examples. He enters a plea for experimental research in the cultivation of microscopic organisms under varied conditions, and we may suggest to the keen amateur that the tracing of the subsequent history of such androgynous specimens which, *e.g.*, exhibit a male antenna on one side and a female antenna on the other, would form an interesting study.

Beating of the Early Embryonic Heart.—The Report of the Department of Embryology of the Carnegie Institution of Washington (from Year Book No. 24), which is located in Baltimore, shows the wide range of investigations in progress, *e.g.* on cleavage stages in the pig, the origin of the notochord, the development of the blood-cells, and a re-analysis of the different types of cells by the aid of staining living blood smears, the study of early human embryos—a well-preserved 7-somite embryo has been carefully investigated—and a number of other lines. Of interest to all biologists is P. N. Johnstone's work on the heart of living chick embryos. In addition to making observations on the morphology of the living embryonic heart he has studied the origin of the first pulsations, and finds they first appear at the 10-somite stage in the primitive ventricle. Starting at a definite spot on the right border of the ventricle, the beating area spreads until the entire ventricle is engaged in rhythmic contractions. It is some time later that the pulsations begin in the primitive sinus venosus, so that at the outset the sinus venosus does not serve as a "pacemaker" for the ventricle. The author further confirmed this by placing a ligature between them which did not alter the rhythm of the ventricle, but later, by the fourth day of development, such a ligature produces heart block, showing that the rôle of pacemaker or rhythm control has then shifted to the sinus venosus. Mr. Johnstone devised a method for stimulating these small hearts electrically, and found that the earliest period at which the chick's heart can be influenced by electrical stimulation is the middle of the third day: that is, long after the atrium, permanent ventricle and bulbus arteriosus have become functionally active.

The Classification of Insects.—*Bull. 162, Agri. Research Inst., Pusa* (1926), is a publication of 101 pages devoted to "Tentative Keys to the Orders and Families of Indian Insects." Its author, Mr. T. Bainbrigge Fletcher, has compiled this synopsis in order to meet a long-standing want for a modern guide to the detailed classification of Indian insects. Present-day tendencies are towards the recognition of an increasing number of orders and families among insects, and it has become progressively difficult for isolated workers, in a country so extensive as India, to keep in touch with recent changes. Mr. Fletcher has, to a large extent, followed the classification of Brues and Melander (whose system is based upon that of Handlirsch), and recognises thirty-two separate orders. In many cases it is still largely a matter of opinion as to what criteria are to be accepted as being of ordinal value. We note that the author has wisely united the Mallophaga and Pediculina (Siphunculata) into the single order Anoplura; but, on the other hand, the Zoraptera and Psocina, which are closely related to each other, are retained as separate orders. The increasing number of families of the larger orders is the outcome of specialisation and intensive study; and, in India alone, there are 86 families in the Coleoptera, 75 in Hymenoptera, and 73 in Lepidoptera. The fact that only a small number of families do not find a place in these keys (since they are unrepresented in India) is a feature commending the Bulletin to workers in other lands besides those in the country for which it is written.

Winsconsin Algæ.—Of great interest to algologists is the publication of the second part of Prof. G. M. Smith's "Phytoplankton of the Inland Lakes of Winsconsin" (*Bull. Univ. Winsconsin, Serial No. 1270*, pp. 227, 1924). This volume deals with the Desmidiaceæ. It quite reaches the high standard set by the earlier publication, and it is a necessary work of reference to all interested in this subject. Four new species and seventeen new varieties are described, most of them belonging to the genus Staurastrum. Among a small number of new combinations is the transfer of *Dictyocystis Hitchcockii* (Wolle) Lagerheim to Cosmocladium. The work of European authorities, notably West and Borge, has been thoroughly assimilated and collated.

The Swamp Cypress of China.—At a meeting of the Royal Irish Academy on March 16, a paper was read by Prof. A. Henry, giving a detailed account with photographs and drawings of the Chinese swamp cypress, known to science as *Glyptostrobus pensilis*. This species has died out in the wild state, and is only known in cultivation in two restricted localities around Canton and Foochow. It has been preserved from extinction by the superstitious beliefs of the peasants, who plant it on the north side of villages to bring luck, and amidst rice-fields to increase the crop. Adapted to wet, marshy situations, it develops peculiar curved "knees," which are woody growths from the roots, projecting above the ground. The function of the knees is to enable the roots to breathe, whenever the soil happens to be inundated. The genus is a very ancient type, and its fossil remains have been found throughout the Tertiary era, widely spread over the northern hemisphere in North America, Europe and Asia, extending as far north as Spitsbergen, Greenland and Alaska. Its twigs and leaves have been gathered in the Eocene beds at Ardtun in the Isle of Mull, in company with similar remains of two other genera, Ginkgo and Cryptomeria, all three being now represented in China by three living species, which can scarcely be distinguished from those that flourished at the beginning of the Tertiary era. Ginkgo is also unknown at the present time in the wild state, and owes its preservation to the Buddhist priests who plant it around their temples. Prof A. Henry, who was assisted in the microscopical work and drawings by Mrs Marion McIntyre, gave in addition a comparative account of the American swamp cypress Taxodium, which is much better known to science than Glyptostrobus. The photographs of the latter, obtained recently from China, are the first to be published of this interesting tree.

Cotton in Tanganyika.—The report of the Department of Agriculture of the Tanganyika Territory for 1924–25 shows, among other developments, a remarkable extension of cotton-growing among the natives. The Department is the only legal source of cotton-seed supply to natives and the chief source to non-native planters. Figures show an increase in seed distribution to natives from 481 tons in 1923 to 1594 tons in 1925. The lint production has increased by 64 per cent. in the last year. Furthermore, it is of interest to note the general superiority, as judged from brokers' reports, of the native-grown cotton over that raised on non-native estates. Extensive experiments are being carried out on the time of sowing in relation to rainfall and on the spacing that gives the best results. Studies of the pink bollworm of cotton, which has apparently been known in Tanganyika since the Germans imported seed in 1898, leads to the probability that it is not indigenous but was introduced from India through Egypt. With the strict control on the movements of seed, it is hoped that this pest may be kept in hand.

Surveys in Somaliland.—In the January-February number of the *Bolletino* of the Royal Italian Geographical Society, Messrs. G. Stefanini and N. Puccioni give a long account of the expedition to Italian Somaliland in 1924, undertaken by Mr. Stefanini under the auspices of the Italian Government and the Italian Geographical Society. A map on a scale of 1 to 1,500,000 accompanies the paper and covers the south-western part of the country as far as the Juba river. A number of short papers dealing with the general scientific results of the expedition, in particular anthropology, are appended.

Historical Russian Diamonds.—The jewels of the "Russian Diamond Treasure" have recently been thoroughly examined by the distinguished mineralogist Dr. A. Fersman, and in a series of papers of historical as well as scientific interest, many of the legends and misconceptions that have crept into the descriptive literature of these stones are corrected (*Bull. de l'Acad. des Sciences de l'U.S.S.R.*, 1922, 1925 and 1926). The "Shah" diamond is a remarkable elongated octahedron of Indian origin, which bears engraved inscriptions of three different dates. Soon after the first engraving in 1591 it passed into the possession of the Great Moguls, and in 1665 it was seen by Tavernier in the palace of Aureng-Zeb. In 1739 it was seized by the Shah Nadir and carried from Delhi to Persia. In 1829 a Russian diplomatic agent was murdered in Teheran, and to conciliate the Tsar the famous gem was presented to Russia. The "Orlov" diamond is the largest of all the old stones of Golconda, and it is now identified by Fersman as the "Great Mogul," also seen by Tavernier in 1665. The Shah Nadir possessed this beautiful gem for some time after the conquest of Delhi, and with the "Koh-i-noor" it was mounted in the Persian throne. The "Orlov" was stolen and passed through various adventures until 1773, when it was purchased by Prince Orlov and presented to Catherine II. Since then it has held pride of place in the sceptre of the late Tsars. The "Koh-i-noor," which has often been described as the "Great Mogul," lost its historical Hindu form in 1862, when it was re-cut, after having been presented by the East India Company to Queen Victoria in 1850.

PLATINUM DEPOSITS IN SOUTH AFRICA.—In the *Trans. Geol. Soc. S. Africa*, vol. 28, 1925, pp. 83-133, Dr. P. A. Wagner describes the platinum occurrences in the norite zone of the Bushveld complex. Taken as a whole, they constitute the world's greatest primary concentration of that metal, the localities of the deposits being scattered along the norite periphery for nearly 400 miles. The distribution indicates that extreme magnetic differentiation was essential for platinum concentration It is shown that in dunite, unusual basicity of the residual fractions, together with the presence of fluorine, were the most probable conditions essential to the formation of rich deposits. The metal also occurs with magmatic nickel-copper-iron sulphides which are indigenous to the rocks in which they occur. The sheets of sulphidic rocks are invariably floored and roofed by anorthosite, suggesting a preliminary necessity for the separation of calcic felspar, and indicating a type of differentiation dependent not on gravity alone, but more particularly on gas pressure Here sulphurous gases were presumably responsible both for the peculiar rock differentiation and for the extraction and concentration of the platinum. Where the sulphidic magmas were brought into contact with dolomites or sheared banded ironstones, contact deposits of platinum-bearing sulphides were formed. The paper is a most valuable contribution both to economic geology and to the theoretical aspects (which still remain confused) of ore-genesis and magmatic differentiation. The views of W. H. Goodchild and J. E. Spurr on these topics are here supported by much of the newly recorded evidence.

THE JAPANESE EARTHQUAKE OF 1923.—Continuing his investigation of the great Kwanto earthquake, Prof. T Ogawa now presents evidence in favour of the hypothesis of magmatic injection, and adverse to the alternative tectonic theory (*Jap Journ of Geol. and Geog*, vol 3, No 3). Omori determined the mean depth of the hypocentra of shocks in the Kwanto region as 34·5 km., and Ogawa combines this result with Shida's conclusion that the 1923 earthquake began as a deep-seated fracture. The depth of fracture is so great that an injection of magma seems to be implied as the underlying cause, particularly as the depth is also that deduced from other evidence as the upper boundary of the magmatic zone. On plotting the epicentra of all the great shocks of the region since the twelfth century, they are found to coincide with a zone of eruptive rocks. It is suggested that the association of volcanic eruptions with great earthquakes—recognised in South America long ago by Humboldt and Darwin—is a genetic one. The extraordinary 'depressions' and 'upheavals' of Sagami Bay revealed after the 1923 earthquake provided evidence for the tectonic theory, but Ogawa shows that this is not conclusive He interprets the changes of level as due to the shifting of sediments of mobile consistency by a process of submarine gliding initiated by the earthquake and intensified by the long waves of the *Tsunami*. The new explanation further accounts for the fact that the alleged crustal movements are limited to the floor of Sagami Bay and do not extend to the surrounding land.

THE LAW OF FORCE WITHIN THE ATOM.—In two papers which were communicated to the Vienna Academy of Sciences in 1924 and have now been issued as parts 9 and 10 of volume 133 of the *Sitzungsberichte*, Dr. Hans Pettersson describes his observations of the number and ranges of the H-particles ejected from carbon, aluminium, magnesium, nickel, and copper at angles exceeding 150° from the paths of the α-particles used in bombarding the atoms. He finds that the numbers are less than would be expected on the current theory, and concludes that some of the bombarding particles are retained by the nucleus. He also shows that the change from repulsion of like charges by each other to attraction at atomic distances, which observations have rendered probable, may be explained by the displacement of the negative charges of the nucleus towards, and of the positive away from, the approaching α-particle without departing from Coulomb's law. On this theory the surface of zero force has a radius for carbon of 1·34, for aluminium of 1·22, and for gold of 1·09 times the radius of the nucleus.

THE SULPHUR COMPOUNDS OF KIMMERIDGE SHALE OIL.—Technical literature contains numerous references to the sulphur content of Kimmeridge shale oil, and numerous unsuccessful attempts have been made to eliminate this undesirable constituent. Most of these trials have proceeded, however, without any knowledge of the form in which the sulphur occurs. It was left to Messrs. F. Challenger, J. Haslam, R. J. Bramhall, and J. Walkden to determine the problem, and the results of their work were presented to the Institution of Petroleum Technologists on February 9 last. So far back as 1885 Victor Meyer established the presence of thiophen and its homologues in coal tar, a factor having direct bearing on the sulphur condition in shale oil; subsequent researches of Mabery on American petroleum, Thierry on Persian crude oil, and Scheibler on shale oil from the Tyrol and south of France, led to the recognition of thiophen derivatives in these oils. In their investigation the authors paid special attention to that portion of the Kimmeridge oil volatile in steam, representing an average of 30 per cent., and successive fractions of the oil were examined independently. The fractions tested were—(i.) 93°, (ii.) 109°-117°, (iii.) 117°-126°, (iv.) 132°-140°, (v.) 158°-167°, (vi.) 105-115/27 mm, (vii.) 115-140/27 mm. From (i.) a small amount of thiophenmercurichloride was obtained on treating part of the fraction with alcohol, mercuric chloride, and sodium acetate. In the case of (ii.) a large amount of 2-methylthiophen was isolated; the presence of 2-ethylthiophen and 2 : 3-dimethylthiophen (2 : 3-thioxen) was established for (iv). Fraction (v.) yielded a complex derivative, not yet definitely identified, approximating to the propyl-, methylethyl-, or trimethylthiophen. From the fraction (vi.) naphthalene and thionaphthem were obtained by use of picric acid and mercuric acetate; the compound thiophthen is also suspected in this portion of the oil. As will be noted, these products are all derivatives of thiophen, but the authors have also succeeded in establishing the presence of tetramethylene sulphide and similar derivatives. These results may lead to the formulation of a successful desulphurisation process.

Dutch Pendulum Observations in a Submarine with a New Apparatus.

AT the request of the Dutch Geodetic Committee, the Minister of Marine has once more allowed Dr. Vening Meinesz to make pendulum observations on board a submarine of the Royal Navy, bound for Java, on the voyage from Helder to Alexandria[1] He left Helder on October 15 on board H.M. Submarine K XI, and arrived at Alexandria on November 12, after having touched at Sevilla and Tunis. On November 23 he embarked at Port Said on board the Dutch mail-steamer *Koningin der Nederlanden* and disembarked on December 5 at Amsterdam

The main object of the voyage was the trial of a new pendulum apparatus constructed on the lines described by Dr. Vening Meinesz in No 5, Janvier/Mars 1925, of the *Bulletin Géodésique*, the organ of the geodetic section of the Geodetic and Geophysic Union. With the consent of the Minister of "Waterstaat" and the director in chief of the Royal Meteorological Institute at de Bilt, Prof. Dr. E. van Everdingen, the apparatus was constructed in the mechanical workshop of this Institute by the chief instrument-maker, Mr L. L. M van Rest, with the co-operation of the assistant director, Dr C Schoute[2]

A detailed description of the apparatus with the necessary illustrations will appear in a publication of the Geodetic Committee, for the time being the following cursory description may suffice.

The whole apparatus consists of three parts: the support with the pendulums, the suspension apparatus and the recording apparatus.

The support contains three quarter-metre pendulums of the common Von Sterneck model, the same as were used on the first voyage. These are of brass, not of bronze as was stated erroneously in my former communication.

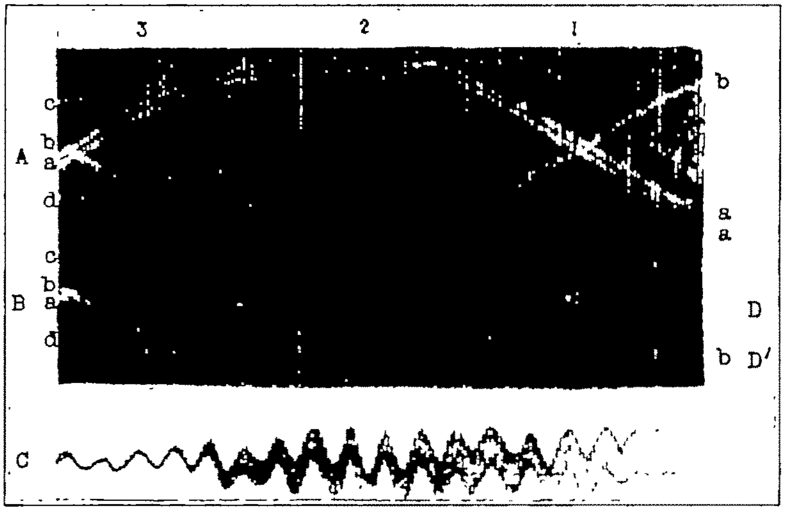

FIG. 1.—November 2, Tunis Harbour A and B, curves of hypothetical pendulums (overlapping) Time gaps showing four curves *a* and *b*, sidereal time (short period), *c* and *d*, mean time (long period) C curve of middle pendulum Inclination of plane of oscillation. D, damped pendulum, D′, undamped pendulum

The three pendulums are rendered as near as possible isochronous They oscillate in the same plane and can be set going simultaneously with an exactly adjustable amplitude. The oscillations are recorded on a moving photographic film by the light reflected by a mirror fixed to the pendulum, but not, as with the former apparatus, for each of these separately. The light-ray reaches first the mirror of the first pendulum, next that of the second. It records in this way the difference of the elongation angles. The result is that the film gives the curve of a hypothetical pendulum, of which the revolving vector is the difference of the vectors of the constituent pendulums As the disturbances of those, caused by the horizontal accelerations due to the movement of the vessel, are the same, their effect is eliminated from the hypothetical pendulum

In the same way, a second hypothetical pendulum is recorded by the third pendulum in combination with the second The two curves give two independent results, which control one another and increase the accuracy.

For the amplitude reductions of the observations, the movement of the second pendulum must be recorded separately; the ray which performs this is on its way reflected by a small, highly damped pendulum, of a construction devised by Dr Vening Meinesz, the plane of oscillation of which is parallel to that of the other pendulum. In this way the movement of the middle pendulum is recorded with respect to the vertical.

A second highly damped pendulum of the same construction, the plane of oscillation of which is perpendicular to the plane of the others, serves to record the inclination of this plane during the observations It was controlled by a small undamped pendulum, but the results proved that this control is not necessary

The changes of temperature within the apparatus during the observations are recorded by means of a metallic thermometer.

Before the rays of light enter the support, they pass a lens that makes them parallel. When leaving it they pass a second lens that collects on the film the constituents of every bundle of rays Within the apparatus each bundle is compelled to follow its path by a number of mirrors or prisms In every path there is one adjustable prism by which the distribution of the curves on the film can be regulated

Between the observations the pendulums are not to be removed, they can remain in the apparatus, even when the motion of the vessel is most violent. By turning a small handle the knives of the pendulums are lifted from the agate planes on which they oscillate during the observations. By moving a second handle the double cone at the lower end of each pendulum is fixed between four arms The fastening is strong, but elastic, in order to avoid the effect of shocks on the pendulums. The disposition is such, that when the pendulums are free it is impossible for any one to turn the handle that commands the arms below before the pendulums are lifted, or when the pendulums are fastened, to turn the handle that lowers them before the arms are removed

The brass top and base plates of the support are connected by strong vertical slabs, the top plate carries the pendulums, the fixed mirrors and prisms and the two lenses. The three agate planes on which the knife-edges of the pendulums rest lie in exactly the same plane, they have been ground and adjusted by the firm Hahn in Cassel (Germany). The base plate rests on three foot screws; parallel to the plane of oscillation of the pendulums a small level is affixed; the bubble is, during the observations, in constant movement owing to the rolling of the vessel, the pendulums must be set free the moment that the bubble is at zero, in order to begin the oscillations with the desired amplitude. Between the top and the base plate are placed a dummy pendulum with thermometer and a hair hygrometer.

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[1] Particulars of the voyage on board H M. Submarine K II from Helder to Batavia in 1923 are given in NATURE of September 15 and December 1, 1923, and March 1 and May 3, 1924

[2] If geodetic offices in other countries should wish to purchase a similar apparatus, the "Nederlandsche Seintoestellenfabriek" at Hilversum will undertake the construction

The support is encased in a metallic cover with double walls, resting on the base plate; the interstice is filled with a bad conductor of heat. A receiver is not needed. The time of an observation being about thirty-five minutes, it is not necessary to operate in a vacuum, which would cause a great complication. In the cover are three windows one for each of the two lenses and one for reading the thermometer and the hygrometer.

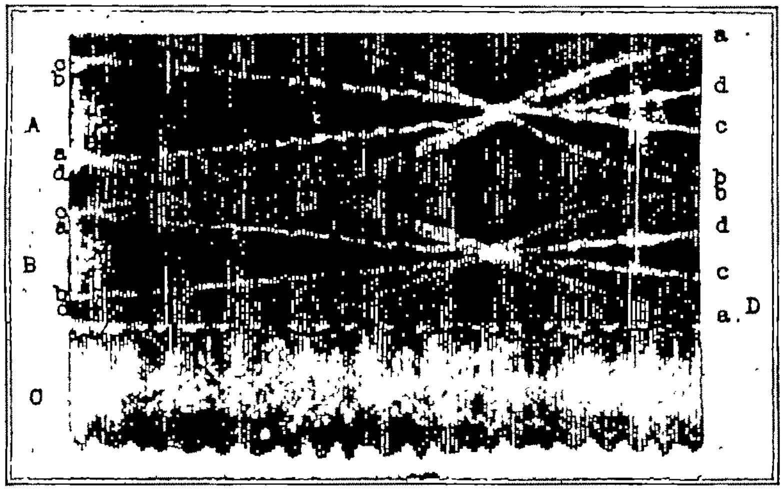

Fig 2.—November 10, Mediterranean Sea, submerged. Curves as on November 2. Undamped pendulum D′ absent.

The whole is placed in the suspension apparatus, the plane of oscillation of the pendulums perpendicular to the suspension axis. The latter must be parallel to the keel of the vessel; in this way the effect of the rolling is neutralised. Originally the apparatus was suspended from pivots, but as the friction caused sudden jerks, these were replaced during the stay at Sevilla by knives, which proved most satisfactory.

The recording apparatus contains two compartments: the small light box and the larger film box.

Behind the light box is placed a Wolfram arc-lamp; the rays of this enter the box through a hole in the back. In the front wall is the small horizontal light-slit, 0·2 mm. wide and 5·0 mm. long, through which the rays leave the box. The interior contains the apparatus for the electromagnetic movement of two shutters, governed by a pair of chronometers, each of which every half second prevents for a moment the light-rays from passing the slit.

The film box contains two vertical cylinders, one bearing the film, which by a clockwork is gradually wound round the other. By the displacement of a lever the velocity with which the film moves can be made 1·0 or 0·33 mm. per second; the first is used at the beginning and the end of the observations, the latter in the intermediate time. Between the cylinders the film moves past a vertical slit in the front wall of the box, 9 mm. wide and 12 cm. high; through this pass the rays coming from the support. The lenses form images of the light-slit on the film, but by a cylindrical lens placed before the recording-slit they are reduced to points. The distance between the optical centres of the lenses is the same as that between the light-slit and the recording-slit. As both slits and both lenses are placed symmetrically with regard to the suspension axis, the place of an image of the light-slit on the film is not changed by the relative movements of the free hanging support and the steady recording apparatus which are caused by the rolling of the vessel.

By the movement of the film the bundles of rays describe the different curves, which, owing to the periodical movements of the shutters, show small gaps that indicate the time elapsed.

The distance between the support and the recording apparatus is 1·03 metre; a tube of blackened cardboard joins the second lens and the vertical slit, and prevents undesired light striking the film.

The two chronometers, constructed by Nardin at Locle, Switzerland, are excellent timekeepers; the irregularities of the daily rate do not exceed 0·1 sec. One, giving sidereal time, has been in use since 1903, the other, giving mean time, is new. It was judged useful to have two chronometers for the purpose of checking each other.

It may be said that in practice the apparatus has surpassed our expectations. The curves recorded on the film are perfectly clear and distinct; their appearance is wholly different from that shown by the films obtained in 1923. This may appear from the accompanying specimens (Figs. 1 and 2) when compared with those given in the *Geographical Journal* for June 1925. The amplitudes of the hypothetical pendulums are entirely regular, which proves that the influence of the horizontal accelerations is wholly eliminated. Letting alone the slow decrease caused by the damping, the amplitudes do not vary more than 0·1 mm., that is 2 to 3 per cent. of the whole amplitude. The vertical accelerations are only perceptible in the track of the half-second gaps, which show slight fluctuations, by tracing a straight line through a number of them the influence is easily eliminated.

Sliding of the pendulums is only to be feared in peculiar circumstances. Thanks to the suspension apparatus, the rolling has no influence, but when the pitching exceeds a few degrees, sliding is noticeable, and the images may even altogether disappear from the film. By the use of the horizontal rudder the pitching of a submerged submarine can generally be greatly reduced, if necessary, after submerging to a greater depth.

Observations with the suspending apparatus hanging free or fastened, executed in quiet water, proved that there is no systematic influence caused by this apparatus.

The advantages of the new apparatus over the old one may be summarised as follows:

1. The exertion required from the observer is a great deal less; he is not compelled during the observations to keep the body in a cramped posture under a black cloth, such as covered the old apparatus.

2. The measurement of the films is very easy, thanks to the clearness and regularity of the recorded curves.

3. The computations are simplified; as the films directly give the movement of the hypothetical pendulums, these have not to be derived by computation from the curves for each separate pendulum.

4. The accuracy of the observations is greater; it is not inferior to that of observations on land.

5. The apparatus may still be used in circumstances where the old one would be useless.

As to the accuracy of the results, it may be remarked that two circumstances unconnected with the apparatus make it somewhat less than that obtainable on land. The first is the varying rate of the chronometers, which may differ during the observations from the mean value, deduced from the time-signals. If scientific radio time-signals of very high precision could be obtained every hour, this would meet the difficulty. The influence is lessened by the use of two chronometers

The second circumstance is the displacement of the vessel during the observations by the sea currents and the resulting contribution to the Eötvös effect. This cannot be determined with accuracy and an average value must be used. I think it improbable that this difficulty will be easily removed.

On board, the apparatus was placed in the central compartment, near the metacentrum, between the two periscopes, one of which was lifted to enable the light-rays to pass

At the beginning of an observation, the first and the third pendulum were set in motion with the desired amplitude. The middle pendulum, hanging free, began to oscillate through the horizontal accelerations caused by the movement of the vessel

The depth of the sea was found by applying the echo method by means of the underwater clock-signals. The lapse of time between the giving of the signal and the perception of the echo was determined by a stop-watch

The time-signals used to determine the rates of the chronometers were generally those of the Eiffel Tower, Bordeaux or Nauen. The relative rate of the chronometers during the observations could be deduced with very great accuracy from the half-second gaps on the films. So far as the computations have been executed, they agree fairly well with the mean relative rates deduced from the time-signals.

During the voyage the following observations were made:

October 17. Mouth of the Channel, near the French coast.
„ 18. Bay of Biscay, not far from the Spanish coast.
„ 26. Sevilla, on the Guadalquivir.
„ 28, 29, 30. Mediterranean Sea, between Gibraltar and Tunis.
November 2. Harbour of Tunis.
„ 8, 9, 10. Mediterranean Sea, between Malta and Alexandria.
„ 12. Harbour of Alexandria.

Some of the observations have been provisionally computed; the results for the harbours of Tunis and Alexandria differ respectively by 0·001 and 0·007 cm./sec.$^{-2}$ from the values obtained in 1923.

The weather was generally very fine and the sea smooth; but on November 27, after the vessel left the harbour of Tunis, a heavy gale was blowing, which prevented the making of observations. The small number of observations in the Atlantic Ocean must be imputed to the circumstance that the time fixed for the track from Helder to Sevilla allowed but small delay. The observations in the Mediterranean Sea constitute a valuable complement to that executed in 1923.

November 26, on board the mail-steamer *Koningin der Nederlanden*, between Crete and Sicily, Dr. Vening Meinesz made a series of observations. The sea was very smooth and the movements of the ship slight The apparatus was placed in a state-room; practical difficulties prevented the use of the suspension apparatus. Some of the observations had to be repeated because of the sliding of the pendulums. The films show the influence of the vibrations caused by the engines, but the amplitudes are very regular. The weather during the rest of the voyage prevented further experiments being made, but it appears from the results that in favourable circumstances it is possible to use the apparatus on board a mail-steamer.

I think that Dr. Vening Meinesz may be heartily congratulated on the success he has achieved with his apparatus. The Geodetic Committee cherishes a strong hope that he will be enabled in the course of 1926 to use it on a second voyage to Java, but this time through the Panama Canal, in this manner concluding a series of determinations of gravity at sea all around the world.

J. J. A. MULLER.

Life in the Bed of the Sea.

IN recent years many attempts have been made to obtain more definite information than the older naturalists had about the composition and the *constitution* of the collections of animals living in the bed especially of the European shallow seas. It was known in a vague way that certain animals were to be found, for example, in a muddy and others in a sandy bottom at certain depths; hence the challenge to modern naturalists to clarify the condition of our knowledge.

The first serious attempt was made by Allen on the grounds off Plymouth, and it was proved clearly that certain forms were definitely associated in that locality with a certain type of bottom which was defined in terms of the percentage composition *in situ* of the particles composing the ground soil. Later, Petersen, employing an approximately accurate instrument, the grab, for taking a definite area of the sea-bottom, obtained figures which showed which animals were really dominant and characteristic in the different areas examined, but that worker failed to follow up Allen's precise work on the physical composition of the soil, and therefore failed to obtain critical information on the problem attacked. Other workers—notably Ford, who attempted to combine the methods of Allen and Petersen—followed, and have in the main always found communities of animals, but communities also in the main in their own particular locality of silty, muddy, sandy, gravelly or stony soil.

It has remained, however, for Davis in a recent publication[1] to combine to some extent the methods of the two chief investigators. Petersen had found different groups of animals living together in different localities and suggested that such animals lived in *communities*, which, however, might vary in different geographical but equivalent localities by the dropping out or addition of certain members. The later worker went further than this and tried to predict the 'communities' which might be expected to occur in (quantitatively) unknown faunas off the European coast.

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[1] Ministry of Agriculture and Fisheries Fishery Investigations, Series 2, Vol. 8, No. 4, 1925: "Quantitative Studies on the Fauna of the Sea Bottom" No 2: "Results of the Investigations in the Southern North Sea, 1921–24." By F. M. Davis Pp. 50 (London · H.M. Stationery Office, 1925) 5s. net.

By his use of the term 'community' Petersen seems to imply more than Hjort does, for example, in referring to 'societies' or communities of plankton forms in the different hydrographical regions of the Atlantic, or than botanists do in referring to ecological groups of plants, and by his relative neglect of soil analysis gives more importance to the mere association of animals than to the relation of the animals to the nature of the soil. In this attitude Petersen has in part followed Mobius, who long ago (1877) stated that the animals living on an oyster bed form a community, and goes on to say that "Science possesses, as yet, no word by which such a community of living beings may be designated . . . where the sum of species and individuals, being mutually limited and selected under the average external conditions of life, have, by means of transmission, continued in possession of a certain definite territory. I propose the word *Biocœnosis* (from *bios*, life, and *koinoein*, to have something in common) for such a community."

Obviously all these are the beginnings of attempts in marine zoœcology or *zoocœnosis*; and we are witnessing the early stages in the evolution of a nomenclature and, indeed, of method. Davis adopts, but unfortunately, we think, in a modified way, the Allen-Borley method of soil analysis, and pays insufficient attention to the hydrographical and topographical variants, which both Petersen and Borley noted. Thus in no case are all the correlated observations to date marshalled in such a way as to indicate an enduring natural classification of such associations or groups as do undoubtedly occur, although Petersen's broad method of treatment alone has certainly carried the problem beyond its initial stages. In his paper, Davis gives a remarkable table showing soil-analyses correlated with the animals inhabiting particular soils and clearly shows that a large number of animals prefer a particular soil in the North Sea, though some are more catholic in habitat. The author concludes that animal associations were found, but that in detail those groups (communities) which Petersen found are not homogeneous in nature when regarded in relation to the soil analyses, nor strictly comparable with one another in the areas investigated.

We hold, however, that there is not enough information available for the latter part of the conclusion, since (1) Petersen gives no analysis of soils to define his communities, (2) the fauna in relation to known soils has not been adequately investigated at stations linking Petersen's scene of work with the North Sea stations, (3) Davis has himself grouped together animals only in relation to soils without consideration of other biological factors—despite Borley's warning—and (4) what is more important, the biological significance of the soil and medium for the animals inhabiting them has scarcely yet been considered, and a close study of individual species will be required to give the information needed on this point.

The trend of modern work is indeed to delimit and to come to grips with the problem of the relation of any animal to its habitat. The essence of the work on marine animal communities is the provision of a complete description of the factors of the habitat and the inter-relationships of the members, and the results should be stated so as to be capable of comparison or contrast with one another in all parts of the world. J. H. O.

Applied Psychology.

Prof. J. McKeen Cattell, the retiring president of the American Association for the Advancement of Science, gave in his address at Kansas City on "Some Psychological Experiments," a portion of which was published in Nature of January 16, an illuminating account of the development of the experimental study of individual differences. Starting with a description of the measurement of a simple sense reaction time, he proceeded to show, step by step, how the same type of objective measurement can be used in such a complicated action as the selection of a career.

Although no striking new experiments were described, Prof. Cattell's account of the recent applications of psychology was both original and stimulating. "Daily, weekly and seasonal curves," he says; "the optimum periods for definite tasks and for a day's work; industrial fatigue; temperature, ventilation and humidity; the most desirable sexual relations, food, amount and distribution of sleep; rest, play and physical exercise, the use and misuse of emotional excitement and of drugs as sedatives and stimuli: these have been the subjects of many investigations. . . ."

An interesting point discussed by Prof. Cattell is the variation of the curve of ease of learning with age. It is well known that a young child can learn to pronounce a foreign language more easily than can his father and mother. Three years is found to be the optimum age for acquiring pronunciation, and after the age of twelve years it can but rarely be learnt correctly. In the same way other abilities—both physical and mental—have their optimum learning curve at various ages. It is an important task for the educational psychologist to examine the practice curves of the ordinary school subjects at different age levels, so that he can suggest at what stage they should be commenced. Mathematical relations, Prof. Cattell finds, are generally taught a couple of years before the child's age allows him to respond to them with the least effort.

Reference is made to the work that is being done in England by the National Institute of Industrial Psychology to reduce industrial fatigue. Psychologists have found that by arranging for suitable alternative periods of rest and exercise, and by supplying training in the use of the most physiologically economical movements, it is possible to increase the output of the worker—be he miner, mill-hand, or typist—and simultaneously reduce his fatigue. Prof. Cattell outlines the enormous economic importance of this work and describes how in America a Psychological Corporation has been formed to advance this new science, to allow of research, and to protect the interest of psychologists. "The Father of American Psychology," as Prof. Cattell is well named, is the president of this Corporation, and its establishment has already been amply justified. W. J. G. S.

University and Educational Intelligence.

Birmingham.—Dr. Daniel Hanson, principal assistant in the Metallurgy Department of the National Physical Laboratory, Teddington, has been appointed to the Feeney chair of metallurgy, which will be vacated by Prof. T. Turner at the end of the current session.

Mr. J. Armitage Robertson has been appointed assistant lecturer in zoology.

London.—The following doctorates have been conferred: *D.Sc.* (*Chemistry*): Mr. H. T. S. Britton (King's College and Imperial College—Royal College of Science), for a thesis entitled "Part I. Some Electrometric Studies of Reactions, with special reference to the Precipitation of Basic Salts; Part II Some Studies of Salts of Rarer Metals"; Mr. H. D. K. Drew (Birkbeck College), for a thesis entitled "Heterocyclic Systems containing Tellurium in the Ring"; and Mr M. A. Matthews (East London College and the Sir John Cass Technical Institute), for a thesis entitled "The Reactions of the meso-Hydroxy Anthrones and their Bearing on the Mechanism of certain Reactions"; *D.Sc.* (*Statistics*): Mr. E. S Pearson (University College), for a thesis entitled "Bayes' Theorem examined in the Light of Experimental Sampling"; *D Sc.* (*Geology*): Mr. George Slater, for a thesis entitled "Glacial Tectonics as reflected in Disturbed Drift Deposits," and other papers, *D Sc.* (*Horticulture*): Mr. H. R. Briton-Jones, for a thesis entitled "On the Diseases known as 'Bark Canker' and 'Die-back' in Fruit Trees," and other papers; *D.Sc.* (*Physics*): Mr. L. F. Richardson, for a thesis entitled "Collected Works on Meteorology, Differential Equations, etc."

DR. H. R. BRITON-JONES, lecturer in mycology in the Department of Agriculture of the University of Bristol, has been appointed professor of mycology to the Imperial College of Tropical Agriculture, Trinidad.

MR. FRANK BALFOUR-BROWNE, formerly lecturer in zoology (entomology) in the University of Cambridge, has been appointed professor of entomology in the Imperial College of Science and Technology, South Kensington, in succession to the late Prof. H. Maxwell Lefroy.

APPLICATIONS are invited for two scholarships in connexion with the Manchester Royal Infirmary, namely, the Dickinson research travelling scholarship in medicine, value 300*l* for one year, and the Dickinson pathology scholarship, value 75*l* for one year. Particulars are obtainable from the Secretary to the Trustees, The Royal Infirmary, Manchester. The latest date for the receipt of applications for the scholarships is May 1.

A CENSUS of graduate research students in chemistry in the United States in 1925 shows that of 1763 such students in 121 universities, colleges, schools of engineering and agriculture, medical schools, and schools of pharmacy, 544 were engaged on work in the physico-chemical group of subjects: general, colloid, catalysis, subatomic, electro-chemistry, and photo-chemistry. Organic chemistry comes next with 430 students of whom 44 per cent. were working on the aliphatic series. The remainder are classified under the groups, medicine (333), agricultural, industrial, and engineering chemistry (237), inorganic chemistry (86), analytical and metallurgical (72), sanitary and food (61).

IN connexion with the celebration of the fiftieth anniversary of the Johns Hopkins University, it is proposed to establish a Brooks Research Fund in memory of the late Prof. William Keith Brooks. The income of this Fund is to be used to give to some advanced student in zoology or in botany aid in carrying out his work in direct contact with Nature, as at a tropical marine laboratory, or under other stimulating conditions of environment for growth and widening of experiences. The hope would be that from time to time some man thoroughly devoted to zoology or to botany might receive in this way needed aid at a critical point in his career. An offer of five hundred dollars has been received if a further ten thousand is raised. The Fund will be distinct from that now being raised to celebrate the jubilee of Johns Hopkins. Prof. E. A. Andrews, Johns Hopkins University, is chairman of the appeal committee.

"WHAT every woman's college course ought to include" is a question which has been much discussed of late by the Faculty of Barnard College, Columbia University. The conclusions arrived at as a result of these discussions are described in an article by the Dean of the College, Virginia C. Gildersleeve, in the December number of *School Life*. While recognising that in many fields of work it is almost impossible to say that one subject is for all students more valuable than another and a wide range of choice must be permitted, the College prescribes for all the mastery of certain fundamental tools useful for successful work in any field. These are: "A command of written and spoken English, the ability to read at sight with ease at least one foreign language, a healthy body, and a knowledge of hygiene." To ensure the acquisition of these tools, courses in English composition, spoken English (chiefly for remedying defects of the voice), personal hygiene, and human biology are made compulsory—the three first-mentioned being taken during the first of the four years of college life. All students are also obliged to take, during their four years, appropriate physical exercise. As regards the selection of the remainder of the curriculum, two general rules are laid down. On one hand every candidate for a degree must pursue in some one subject a course, carefully planned and supervised by the department concerned, on lines designed to ensure a fairly thorough knowledge of it. On the other hand, in order to avoid too much concentration, every student is required to reach a certain minimum standard in at least one subject chosen from each of the three groups—languages, literatures, and fine arts; mathematics and natural sciences (including some laboratory work); and social sciences.

A REVIEW of Education in India in 1923-24 by the acting Educational Commissioner, which the Government of India has recently published, shows that in the field of higher education the year was in several respects one of disillusion and reaction. In the University of Allahabad, for example, the new constitution was found to keep the minds of the teachers so engaged in the technicalities of meetings of university bodies that they had insufficient time left for teaching duties. In Bengal a widespread dissatisfaction with the existing university system found expression in a reaction against literary education and a preference for science courses. From Assam came reports that graduates and undergraduates seek employment in vain and create discontent with the system which has brought them to such a plight. The University of the Punjab was reported to be "becoming more and more on the major side of its activities an examining body." The policy of separating the intermediate classes from the university course of study has been found in the United Provinces, where it was tentatively adopted, to be unworkable for the present in the colleges which prepare degree candidates. In Bombay the school-leaving certificate examination does not altogether fulfil the hopes with which it was instituted, and it was decided that the University should resume the conduct of its matriculation examination. The Dacca Vocational Education Committee presented a report in which doubt is thrown on the belief of the Calcutta University Commission that at the intermediate stage vocational education can be so combined with general education as to produce a worker competent to earn his living with the training which he has undergone at the close of that stage. There was also disillusion of a beneficent kind on the part of some political enthusiasts and the effect of the non-co-operation movement on attendance in schools became negligible. The University of the Punjab embarked on a new venture in the opening of its first science laboratory—that of chemistry.

Contemporary Birthdays.

April 11, 1862.	Prof. W. Wallace Campbell, For Mem.R.S.
April 11, 1863.	Mr. Henry Balfour, F.R.S.
April 11, 1890.	Dr. Eric K. Rideal.
April 12, 1851.	Mr. Edward Walter Maunder.
April 14, 1867.	Prof. J. C. M'Lennan, F.R.S.

Prof. W. W. CAMPBELL, the distinguished director of the Lick Observatory, Mount Hamilton, California, and president (since 1923) of the University of California, was born at Hancock Co., Ohio. The development of astronomical knowledge owes much indeed to him during the past thirty-five years, not only for practical issues, but also for valuable contributions to the journals recording theoretical progress in the science of astronomy. He has had charge of many eclipse expeditions, and those who were privileged to act with him have testified to his enthusiasm, powers of organisation, and resourcefulness. Prof Campbell was among those who were successful in adopting the method of employing a moving photographic plate to record the succession of phenomena during a solar eclipse. The Royal Astronomical Society awarded him its gold medal in 1906 for his spectroscopic researches on stellar objects, and work respecting stellar motions in the line of sight. The Paris Academy of Sciences allotted Prof. Campbell the Lalande medal in 1903, and the Janssen medal in 1910, for researches and discoveries in stellar spectroscopy.

Mr. HENRY BALFOUR was educated at Charterhouse and Trinity College, Oxford. Since 1891 he has been curator of the extensive ethnological and archæological collections acquired by the late General Pitt Rivers, F.R.S., and presented by him to the University of Oxford in 1884 Huxley medallist of the Royal Anthropological Institute, and a past president of the Folk-lore Society, Mr. Balfour is the author of many noteworthy memoirs.

Dr. E K. RIDEAL is an old pupil of Oundle; from thence he graduated at Trinity Hall, Cambridge. He is Owen Jones lecturer in physical chemistry in the University of Cambridge. For a year (1919–20) Dr. Rideal was visiting professor of physical chemistry in the University of Illinois, U.S.A.

Mr. E. W. MAUNDER, astronomer, entered the service of the Royal Observatory, Greenwich, as an assistant in 1873, and from that date until 1913 he was Superintendent of the Solar Department. Mr Maunder was educated at University College School, London, and King's College. He has taken part in many eclipse expeditions Author of a number of useful works on practical and popular astronomy, he has in several of these had the happy advantage of Mrs. Maunder's collaboration. He founded the British Astronomical Association in 1890.

Prof. J. C M'LENNAN, Director of the Physical Laboratory in the University of Toronto, though born at Ontario, is of Scottish descent. He received his education at the Universities of Toronto and Cambridge. His attachment to the former began in 1892, and has never been severed. Prof. M'Lennan was president of the Royal Society of Canada, 1924–25. In 1923 he was president of Section A (Mathematics and Physics) at the Liverpool meeting of the British Association; the subject of his discourse was, "On the Origin of Spectra." The Royal Society of Arts allotted him a medal in 1919, for his paper "Science and Industry in Canada." He is D Sc., Manchester and Liverpool.

Societies and Academies.

LONDON.

Royal Microscopical Society, February 17.—**A. Piney**: The principles of hæmatological differentiation. An attempt to classify the normal leucocytes of human blood on purely morphological grounds. The characters of the nuclei must be regarded as the determining feature, particularly the distribution of the two forms of chromatin Cells with sharp distinction of the chromatin into two types were derived from the bone marrow (myeloid cells), while those with incomplete separation of the two substances in the nucleus were of lymphatic origin. The technical details of preparing the films were discussed.

Royal Microscopical Society (Industrial Applications Section), February 24.—**C. A. Klein**: The application of the microscope to the examination of pigments and paints. More precise information is required as to the size of pigment particles in view of the important relationship known to exist between particle size and the subsequent behaviour of paints, in respect to ease of application and also wearing properties The methods of sieving and subsidence frequently used to indicate the fineness of division of pigments have limitations, and microscopical examination is recommended after grading of the material by elutriation, in order to obtain fields of more even-sized particles. The removal of even small proportions of over-sized particles in paint materials is an expensive process. Many problems in connexion with the behaviour of paint films on drying and subsequent exposure could be solved by the proper application of microscopical methods as in the United States of America, where they have been applied to a considerable extent.

Royal Anthropological Institute, March 2.—**Mrs. Janet B Montgomery McGovern**: The head-hunters of Formosa. The Chinese-Formosans of the towns do not differ materially from the Chinese of the mother country; it is among the pseudo-aboriginals of the almost inaccessible mountain ranges that curious customs are observed. Of these tribes the most interesting are the Taiyal, the head-hunting tattooed tribe of the northernmost mountains. A feature of their culture is the government of the tribe by women. Their power is both spiritual and temporal. The chieftainess of each sub-tribe is also the priestess of that sub-tribe. She is assisted by other priestesses, mostly widows. They officiate at marriage and funeral ceremonies, and act as physicians in case of illness, effecting some marvellous cures. The chief priestess also performs the ceremonial tattooing. All the children have their foreheads tattooed in a series of horizontal marks at the age of five years. At marriage, elaborate markings are tattooed on the cheeks of the bride, and on attainment of the rank of priestess further elaborate markings are added. The warriors are also tattooed by the priestess. One function of the priestess is the ceremonial kindling of new fire once a year. From this all fires are re-lighted The priestess also decides when head-hunting expeditions are to be carried out, and in what direction No warrior may marry unless he has at least one head to his credit For each head that is taken, a horizontal mark is tattooed on the chin An essential part of the marriage ceremony is that bride and groom should drink millet wine from a cup made of a skull taken by the latter. A communal system prevails among the Taiyal, the millet, the principal food of the people, being distributed by the high priestess from the communal granaries. A very high standard of personal morality exists among them, and untruths, theft, and unchastity are almost unknown where the people have not come into contact with civilisation.

March 16.—G. Landtman: Some agricultural rites of the Kiwai Papuans. The gardening of the Kiwais, like all their occupations, is interwoven with all kinds of observances purporting to promote the work. When clearing timbered bush the people avoid felling certain large trees which are thought to be inhabited by the *étengena*, a group of sylvan beings. These appear by day as snakes or birds, at night in human form, and are guardians of the plantations. The people give them part of the first-fruits and invoke them in the *karéa*-rite, sprinkling of *gámoda* (*káva*) in the direction of the garden. Most of the fertility rites are first performed in the garden by an old man and an old woman, whose example is followed by the rest of the people. In several of the rites the sexual act plays a part, and one of the principal "medicines" is secretion from the female genitalia, for sago palms the male semen. The people also resort to various methods for depriving an enemy of his luck in gardening, or for summoning pigs to destroy his crop. The old couple generally lead the way in every stage of garden work with their preparatory rites. Each of the principal garden plants is attended by observances of its own. Bullroarers are particularly used for yams. The first few yam stalks are usually tied up with strings which have been employed for cat's cradles "Skipping-rope" is a game which causes the yam roots to grow large. Certain rites at the first cropping of a garden purport to make the food last a long time and prevent the people from being taken ill when eating it. A series of rites referring to the banana gardens are performed by a number of small boys, each with a little "play-wife." These small couples bear resemblance to the various descriptions of "May-brides," etc. The principal feature of the *gaera*, the great agricultural ceremony, is a tree erected on the festal ground with much solemnity, overhung with garden produce and beautifully decorated. A long serial song is sung during the ceremony, describing a journey from Adiri, the land of the dead, in an easterly direction right through the part of the country known to the Kiwais. One cannot forbear recognising one of the many instances of the fertility tree or the tree of life.

Mineralogical Society, March 16.—A. F. Hallimond: On molecular volume relations in the mica group. The 'observed' molecular volume is obtained from the density and silica-percentage, on the assumption that the mica molecule contains the same number of silicon atoms for all members of the group. It is shown that the molecular volumes so obtained are of similar dimensions throughout, but that each of the non-miscible sections, muscovite, lepidolite, etc., has a distinctive molecular volume, in agreement with the chemical classification proposed in earlier papers. The volume is an additive property, and can be expressed as the sum of the volumes of the oxides present. The corresponding absolute molecular volumes for the oxides are in general agreement with those derived from X-ray measurements. Micas deficient in potash do not show a corresponding diminution of volume. Titanium is usually present as TiO_2, but two titanium-rich biotites only give normal molecular volumes when represented as compounds of Ti_2O_3.—E. D. Mountain: (1) Smithsonite from the Rhodesia Broken Hill Mines. Colourless crystals 7 mm. in size, in the British Museum (Natural History), are of the form f(111), striated parallel to longer diagonal; cleavage angle $rr' = 72° 21'$; $H = 4 - 4\frac{1}{2}$; $G = 4·398$; contains 97·34 per cent. $ZnCO_3$. Refractive indices measured on oriented prisms gave for Na-light $\epsilon = 1·6212$, $\omega = 1·8485$. (2) The identity of the Cobija and Lampa meteoric stones. A complete quantitative analysis of Cobija and a partial analysis of Lampa confirm Dr. Prior's suggestion of their identity; $f = 14$, $n = 10\frac{1}{2}$, $m = 5$ (Prior's nomenclature); specific gravity, 3·58. Further evidence suggests that they are two stones of the Cobija fall.—C. E. Tilley: On garnet in pelitic contact zones. In the normal pelitic contact zone, garnet is inconstant in its occurrence, and from many aureoles is entirely absent. The instability of almandine in normal thermal metamorphism is attested by the destruction of this mineral when crystalline schists containing it are involved in the aureoles of the Caledonian granites of Scotland. Aureoles especially conspicuous for the presence of garnet are those of New Galloway, Co. Wicklow, and Skiddaw. Analyses of garnets from these show considerable spessartine percentages, varying from forty to fourteen. The occurrence of garnet in pelitic contact zones (stress zones excluded) appears to be conditioned by the presence of a considerable MnO content, promoting the formation of spessartine bearing types. Almandine proper is characteristically a stress or high-pressure mineral; the physical conditions for its formation are not realised in normal thermal aureoles.

Royal Meteorological Society, March 17.—Sydney Chapman: Some recent advances in atmospheric physics (Symons Memorial lecture). The existence of a strongly ionised layer in the upper atmosphere, required by theories of the daily variations of the earth's magnetism, and also required to explain the long-distance transmission of wireless waves, has recently been strikingly demonstrated by observations of high-angle reflection of short-wave wireless signals at night The wireless and magnetic data for the ionised layer are in fair qualitative and also quantitative accord where they overlap. It appears possible to explain the production of the ionisation by ultra-violet radiation absorbed in the atmosphere by day, certain quantitative difficulties proposed by Swann being found invalid. Additional ionisation occurs, by night as well as by day, in higher latitudes, in association with auroræ. The nature of the ionising agent in this case is somewhat obscure, but a stream of charged corpuscles of opposite signs, but with a slight residual charge, seems the most likely hypothesis. The auroral spectrum suggests that nitrogen is the principal ionised gas in the auroral regions.

Royal Microscopical Society, March 17.—Mohammed Ali: Studies on *B. ægypticus*, Pt. I. The appearance and structure of colonies of this organism upon artificial media and its morphological characters were described. Variations in the H-ion concentration of the medium transforms the minute rod of 1 μ into a filament often thirty times that length, which latter could be restored at will to the type form, thus demonstrating that heritable tendencies are not involved. In this respect *B. ægypticus* behaves in a precisely comparable manner to *B. influenzæ* (Pfeiffer). There is a lack of morphological, tinctorial and cultural difference between these two members of the hæmophilic group of bacilli; the only differentiating point so far observed has been the longer vitality upon artificial media of *B. influenzæ*.

Edinburgh.

Royal Society, March 8 —**N. B. Eales**: The anatomy of the head of a fœtal African elephant. The muscles, blood-vessels, nerves and skeleton are described. Despite its youth, the skull possesses the features of a modern elephant, and the flattening of the facial region at the root of the proboscis has already taken place. No traces of the first premolar or of the lower incisor teeth are present. All the teeth of a young elephant are represented and no others. The fœtal mandible exhibits the *longirostris* condition and is turned downward at the symphysis. Its vertical measurement is relatively shorter and its horizontal measurement relatively greater than in the adult. The shape resembles that of the fœtal elephant's ancestors rather than that of its own parents.—**C. M. Yonge**: The digestive diverticula in the lamellibranchs. The so-called liver or hepatopancreas of the lamellibranchs consists of a great number of ramifying blind tubes, the epithelium of which is composed of one kind of cell only. There is no evidence that the cells secrete or perform any of the functions of a liver or a pancreas; the whole structure is an organ of absorption and intercellular digestion, small particles being directly ingested and acted upon by digestive enzymes within the cells. The only extracellular enzymes in the gut of lamellibranchs are those elaborated in the crystalline style.—**W. Peddie**: Present problems in colour vision: the laws of visual fatigue, and of resultant sensation. The paper deals specially with the form of the relation which expresses the threshold value, that is, the least perceptible value, of an external stimulus, in terms of the external stimulus itself. This expression is then generalised so as to take account of interrelation of effects, and of the influence of any given fatiguing light to which the eye may have been previously exposed This generalisation furnishes an explanation of the peculiar effect of strong precedent fatigue upon the sensitiveness of the eye to spectrum colours, which has been investigated in detail by Prof Frank Allen.—**F. A. E. Crew**: On fertility in the domestic fowl. Fertile eggs are to be expected about 48 hours after the introduction of the male into a pen of virginal laying females; the onset of fertility varies slightly in different matings. The maximum fertility is attained by the end of the first week. Although fertile eggs are laid so long as 21 days after removal of the male, yet should the male be replaced by another, then the influence of the previous sire is removed by the end of the first week. This competitive action of the sperm is probably to be explained in terms of their relative staleness.—**H. W. Turnbull**: The invariant theory of forms in six variables relating to the line complex. A symbolic algebraic basis is given for the treatment of quaternary complex forms which occur in line geometry as forms in six variables, as suggested by Klein. The most general case including point, line and plane co-ordinates is considered. The transformation is reversible.—**Pierre Humbert**: Some hyperspace harmonic analysis problems introducing extensions of Mathieu's equation. Mathieu's differential equation, specially studied by Prof. E. T. Whittaker, is of great importance in harmonic analysis; two other equations, similar to it, are here connected with some new problems in four-dimensional space.—**W. Saddler**: A geometry associated with the double binary (2·2) form. The vanishing of the form as the incidence condition of a point on one conic with a tangent to a second, both represented parametrically, is treated. Canonical forms and the covariants are readily obtained and interpreted, while applications, using two (2·2) forms, are given to the geometry of three conics.

Paris.

Academy of Sciences, February 15 —**Paul Appell**: A principle of statics.—**V. Grignard** and **J. Savard**: The existence of isopulegone in the natural state. The isolation of the α- (iso) pulegones and β- (ordinary) pulegone and their enols in the pure state. The separation is based on the fact that pulegone combines with sodium bisulphite, whilst isopulegone is not attacked by this reagent.—**G. Friedel**: Concerning fatty acids and smectic bodies.—**Axel Egnell**: A property of curvature of certain Riemann spaces.—**Charles Jordan**: The inversion of the theorem of Bernoulli.—**Rod. Fueter**: Improperly discontinuous groups.—**Michel Petrovitch**: Definite integrals bearing on the generalised series of Lambert.— — **Mandelbrojt**: The effective determination of the singular points of an analytical function given by its development in series of powers —**J. Sudria**: A theorem of the vectorial calculus.—**R. Swyngedauw**: An experimental method for the study of the working of belts.—**M. Girault**: The intrinsic equations of the plane parallel motion of incompressible fluids in a permanent régime.—**Y. Rocard**: Conditions at the surface in problems of aerodynamics furnished by the kinetic theory of gases.—**V. Bjerknes**: The temperature of sunspots. The assumption of vortex movements can explain the existence of parts of the sun's surface either locally cooled or heated.—**H. Pélabon**: The mechanism of detection (in wireless telegraphy).—**Léon Bloch**, **Eugène Bloch**, and **Georges Déjardin**: A second spark spectrum of neon. A description of a new spark spectrum of the second order, the lines of which are wholly situated in the ultra-violet.—**Georges Déjardin**: The excitation of the second spectrum of neon by electronic shock.—**E. Darmois**: The mutarotation of mixtures of molybdates and ethyl malate. The probable constitution of the molybdomalic derivatives.—**Albert Nodon**: An electrometer designed for the study of weak radioactive manifestations. The instrument described has a small electrostatic capacity, and indicates variations of 2 volts —**J. d'Espine**: The slowing down of the β-rays by matter —**Max Morand**: The direct determination of the relative proportion of the isotopes of lithium. Making use of an improved apparatus for the production of positive rays, the currents transported by the positive rays of the two isotopes of lithium have been measured, receiving the isotopes on two separated plates, each connected with a galvanometer. The numbers obtained give a ratio of intensity between 14 and 15, corresponding to an atomic weight of between 6·93 and 6·94. The chemical determination of the atomic weight, 6·935, is in good agreement.— — **Herrera**: New experiments simulating living organisms.—**Victor Lombard**: The permeability of nickel to hydrogen. The influence of pressure. The permeability of nickel to hydrogen, within the limits of the experiments described, is proportional to a^{-h}, where h is the thickness of the nickel plate. It is an exponential function of the temperature, and varies proportionally to the square root of the pressure of the gas.—**J. Laissus**: The cementation of ferrous alloys by tungsten.—**R. Cazaud**: Researches on the auto-magnetisation of steels by torsion. The study of the auto-magnetisation of steels by torsion gives a rapid method of identification, capable of furnishing indications of their composition and thermal treatment.—**B. Bogitch**: The composition of copper mattes.—**P. Billon**: The reduction of oximes by sodium and absolute alcohol. Splitting up the racemic amines thus obtained by means of dextrorotatory tartaric acid.—Louis **Longchambon**: The tartaric acids. Study of the preparation and properties of antitartaric acid (inactive).—André **Duparque**: The microscopic structure of coals.—Mlle. Yvonne **Wahl**: Tectonic and stratigraphic observations in the region of the lake of Allos (Basses-Alpes).—J. **Savornin**: The discovery of native gold at Djebel Mekam, near Berguent (Eastern Morocco).—Maxime **Coutin**: A layer of molybdenite in Morocco.—R. **Cerighelli**: The influence of light and temperature on the germination of seeds in the absence of calcium. In the germination of the pea, in the absence of lime, light exerts no influence on the growth of the root and stem, but the temperature has a marked action on each of these organs.—A. **Guilliermond**: The relations of the vacuolar system with the reticular apparatus of Golgi in plants.—Marcel **Brandza**: The influence of heat and of rapid evaporation on calcareous myxomycetes living in full sunlight.—Pierre **Georgévitch**: *Armillaria mellea*, the cause of the drying up of the oak forests of Jugoslavia.—A. **Quidor** and **Marcel A. Hérubel**: The monocular perception of relief by direct observation.—H. **Simonnet** and G. **Tanret**: The action of ergotinine on the uterus of the guinea-pig.—Pierre **Lesne**: A coleopterologic Pliocene fauna in the north of England.—Émile **André** and Mlle. Th. **François**: Contribution to the study of the oils of marine animals. Researches on cachalot and spermaceti oils.—Mme. **Phisalix**: The vaccination of the rabbit against intracerebral inoculation of fixed rabies virus, by subcutaneous inoculation of virus-serum mixtures from the viper, the adder, or the hedgehog, with excess of virus.—**Loubat** and **Dufériè**: The influence of vascular ligatures on experimental gas gangrene.

ROME.

Royal Academy of the Lincei, January 17.—Umberto **Cisotti**: Mechanical actions of a plane current investing two circular profiles separated by a convenient distance.—Secondo **Franchi**: Discoveries of Priabonian foraminifera in the Taveyannaz arenaria, confirming the Eocene age demonstrated for the Annot arenaria in 1916.—Harry **Levy**: Canonical form of the ds^2 for which Riemann's symbols with five indices are annulled.—Alfredo **Rosenblatt**: The case of general collision in the problem of three bodies.—A. **Pontremoli**: New investigations on the accidental double refraction of colloids in motion.—Elena **Freda**: Propagation of stationary electric currents under the action of a magnetic field.—A. **Carrelli**: The compound photo-electric effect.—Giulio **Bemporad**: The principle of the arithmetic mean.—G. R. **Levi** and R. **Haardt**. The catalytic action of metals of the platinum group and their degree of subdivision (1). Measurement of the dimensions of the granules of a number of preparations of platinum black and spongy platinum shows that it is possible to alter the magnitude of these granules by varying the method of preparation. Reduction of cold chloroplatinic acid by means of aluminium yields granules only five times as large as the elementary cell.—P. **Pasquini**: The structure of pecten and its morphological and functional significance in the eye of the bird.

Pontificia Accademia delle Scienze (Nuovi Lincei), February 21.—**Toniolti**: Telluric movement of Amiata at Montalcino.—**Luigioni**: Specific validity of *Anoxia sicula* Motsch, a beetle of the scarab family.—**Gianfranceschi**: The law of distribution of energy in the spectrum of the black body.—**Scatizzi**: A type of derivative of variable index capable of summing its index with another derivative of the first type.—**Silvestri**: Invariable radiophonic receiver.

VIENNA.

Academy of Sciences, January 22.—K. **Hofler**: The iron content and local iron concentration in the cell walls of Desmidaceæ.—A. **Kailan** and J. **Schroth**: The electric conductivity of mixtures of hydrochloric and sulphuric acids with orthophosphoric acids prepared in various ways.—A. **Kailan** and J. **Schroth**: The esterification of malonic acid by hydrochloric acid in glycerin.—R. **Dworzak**: Ester-condensation in relation to the exchange of functional groups under the influence of aluminium ethylate.—B. P. **Wiesner**: The sexual cycle of the rat. (1) The œstrous rhythm and the œstrous cycle; (2) phases of the sexual cycle; (3) castration and extirpation of the suprarenals; (4) periodicity in the secretory function of the ovary and the œstrous rhythm.—O. **Lehmann**: Devastation in the Sandling group in the early autumn, 1920.—L. **Hofmann**: The axonometric theorems of Kruppa and Pohlk in non-Euclidean space. It relates to descriptive geometry and projections and curves of the second degree.—A. M. **Hugetz**: The influence of the alcoholic components on the velocity of saponification of acetic ester.—M. **Skrabal** and M. **Zlatewa**: The velocity of saponification of tetra-acetyl-penta-erytrit.—M. **Glässner**: New Emyden discoveries in the Vienna basin and fossil species of Clemmys in the Mediterranean region.—A. **Kieslinger**: Geology and petrography of the Kor Alps.

Official Publications Received.

Comité International des Poids et Mesures. Procès-verbaux des Séances. Deuxième série, Tome 11, Session de 1925. Pp. v + 105. (Paris: Gauthier-Villars et Cie.)

Catalogue of Indian Insects. Part 10: Stephanidae. By G. R. Dutt. Pp. iii+14. (Calcutta: Government of India Central Publication Branch.) 5 annas, 6d.

Commonwealth of Australia: Bureau of Meteorology, Melbourne. Paper 1, Extract from Bulletin No. 17: Some Periods in Australian Weather. By Dr. Edward Kidson. Pp. 23. (Melbourne: H. J. Green.)

Ministry of Public Works, Egypt: Physical Department. The Climate of Helwan. By L. J. Sutton. (Physical Department Paper No. 20.) Pp. iv + 82 + 17 plates. (Cairo: Government Publications Office.) 10 P.T.

The National Benzole Association. Third Report of the Joint Benzole Research Committee of the National Benzole Association and the University of Leeds. Pp. 20 + 7 plates. (London: National Benzole Association.)

Sixteenth Report on the Sarawak Museum, 1925. By E. Banks. Pp. ii+21. (Kuching, Sarawak.)

Thirteenth Report of the Research Sub-Committee of the Gas Investigation Committee of the Institution of Gas Engineers. 1. Aeration of Lighting Burners; 2. Determination of Specific Gravity of Gases. Pp. 102-167. Fourteenth Report of the Research Sub-Committee of the Gas Investigation Committee of the Institution of Gas Engineers. The Experimental Gas Plant at Leeds University. Sir Corbet Woodall Memorial. Pp. 168-195. (London: Institution of Gas Engineers.)

Report of the Marlborough College Natural History Society for the Year ending Christmas, 1925. (No. 74.) Pp. 130+18 plates. (Marlborough.) 5s.

Suomen Geodeettisen Laitoksen Julkaisuja: Veroffentlichungen des Finnischen Geodatischen Institutes. No. 5: Schwerkraft und isostatische Kompensation in Norwegen. Von W. Heiskanen. Pp. 32. No. 6: Die Erddimensionen nach den europaischen Gradmessungen. Von W. Heiskanen. Pp. 26. (Helsinki.)

Aeronautical Research Committee. Reports and Memoranda, No. 966 (Ae. 196): On the System of Vortices generated by a Circular Cylinder in Steady Motion through a Fluid. By C. N. H. Lock. (A.1 a. Dynamical Similarity, etc., 58—T. 2044.) Pp. 6+1 plate. 4d. net. Reports and Memoranda, No. 993 (Ae. 204): Note on the Minimum Speed from which the Direction of a Gliding Aeroplane can be changed to a Horizontal Path for Landing. By F. W. Meredith. (A.2 a. Calculations and Model Experiments, 96—T. 2108.) Pp. 5+1 plate. 4d. net. (London: H.M. Stationery Office.)

Transactions of the Royal Society of Edinburgh. Vol. 54, Part 2, No. 7: The Scottish Kames and their Evidence on the Glaciation of Scotland. By Prof. J. W. Gregory. Pp. 395-432. 5s. Vol. 54, Part 2, No. 9: The Geology of Videy, S.W. Iceland; a Record of Igneous Action in Glacial Times. By Dr. Martin A. Peacock. Pp. 441-465+1 plate. 2s. 6d. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The National Physical Laboratory. Report for the Year 1925. Pp. 242+23 plates. (London: H.M. Stationery Office.) 8s. 6d. net.

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 37, Part 1. Pp. 115. (London: Edward Stanford, Ltd.) 5s.

Diary of Societies.

SATURDAY, April 10.

Mining Institute of Scotland (Annual General Meeting) (at Royal Technical College, Glasgow), at 3.—J. B. Sneddon: Some Findings of the Royal Commission on the Coal Industry (Presidential Address).—Dr. F. Fergus: Miners' Nystagmus; and Discussions on: The Report of the Institution Committee on Ventilation of Mines; Coal Cutting by Machinery and Conveyors in Scottish Mines, G. L. Kerr; The Adjustment of Ropes on Bi-Cylindro-Conical Drums, Dr. J. Parker; The Problem of In-bye Transport, D. C. Gemmell.

MONDAY, April 12.

Royal Irish Academy, at 4.15.

Royal Institution of Great Britain, at 5.—General Meeting.

Society of Engineers (at Geological Society), at 5.30.—H. B. Creswell: An Inquiry into the Ugliness of Engineering Structures.

Institution of Electrical Engineers (Western Centre) (at Exeter), at 6.—R. B. Matthews: Electro-Farming; or the Application of Electricity to Agriculture.

Institution of Structural Engineers (Students' Meeting), at 6.—E. S. Andrews and others: Discussion on Theory *versus* Practice.

Institution of Automobile Engineers (Birmingham Centre) (at Birmingham and Midland Institute), at 7.—G. Rushton: The L.G.O.C. Methods of Omnibus Repair (Lecture).

Institution of Electrical Engineers (Informal Meeting), at 7.—Capt. P. P. Eckersley and others: Discussion on the Linking together of Wireless and Wire Communication Systems.

Institution of Electrical Engineers (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—C. Vernier: Some Impressions of Chicago and U.S.A. (Lecture).

Institution of Mechanical Engineers (Graduates' Section, London), at 7.—F. C. Johansen: Some Factors affecting the Speed of Passenger Trains.

Aristotelian Society (at University of London Club), at 8.—Rev. E. Hanson: The Problem of History.

Surveyors' Institution at 8.—Discussion of Paper by H. E. Sherwin, On the Various Statutes which comprise the New Law of Property.

Royal Geographical Society (at Æolian Hall), at 8.30.—H. F. Lambart: The Ascent of Mount Logan.

Society of Chemical Industry (London Section).

TUESDAY, April 13.

Manchester Geological and Mining Society, at 4.

Royal Society of Medicine (Therapeutics and Pharmacology Section) (Annual General Meeting), at 5.

Royal Institution of Great Britain, at 5.15.—Prof. J. Barcroft: Organs of Multiple Function (1): The Salivary Glands.

Institution of Petroleum Technologists (at Royal Society of Arts), at 5.30.—C. M. Hunter: The Oil Fields of the Maracaibo Basin.

Zoological Society of London, at 5.30.—Dr. K. Kuiper: On a Black Variety of the Malay Tapir (*Tapirus indicus*).—B. S. Vinogradov: Some External and Osteological Characters of *Prometheomys schaposchnikowi* Satun (Rodentia).—Dr. P. R. Lowe: On the Callosities of the Ostrich (and other Palæognathæ) in connection with the Inheritance of Acquired Characters.—W. S. Bristowe and G. H. Locket: The Courtship of British Lycosid Spiders and its Probable Significance.—Dr. J. Beattie: On the Ileocæcal Region of the Reptiles.—L. *Tupinambis teguexin*.—J. H. Power: Note on the Tadpoles of *Cassina senegalensis*.

Institution of Civil Engineers, at 6.—J. N. Reeson: The Influence of Electric Welding in the Design and Fabrication of Plant and Structures.

Institute of Marine Engineers, at 6.30.—W. S. Burn: Double-Acting Oil Engines.

Royal Photographic Society of Great Britain (Scientific and Technical Group), at 7.—S. O. Rawling: Thiocarbamide Fog and a Suggested Explanation of Waterhouse Reversal.—A. Montagny: Demonstration of the Hilo and Moutix Apparatus.

Institution of Electrical Engineers (Scottish Section) (at Royal Technical College, Glasgow), at 7.30.—Ordinary and Annual General Meeting.

Institution of Engineers and Shipbuilders in Scotland (at 39 Elmbank Crescent, Glasgow), at 7.30.—A. Healey: Dunlop Tyres and their Uses.

Quekett Microscopical Club, at 7.30.—J. Ramsbottom: Fairy Rings and Allied Growths.

Royal Anthropological Institute, at 8.30.—J. Stuart: The Zulus in Peace and War.

WEDNESDAY, April 14.

Royal Institute of British Architects (at 9 Conduit Street, W.), at 5.—F. Inigo Thomas: Gardens (Lecture).

Institution of Civil Engineers (Informal Meeting), at 6.—G. W. Tripp: The Young Engineer: His Training and Prospects.

Institution of Electrical Engineers (Wireless Section), at 6.—E. H. Shaughnessy: The Rugby Radio Station of the British Post Office.

Radio Society of Great Britain (Informal Meeting) (at Institution of Electrical Engineers), at 6.

Institution of Electrical Engineers (South Midland Centre) (at Birmingham University), at 7.—Discussion on Government Electricity Bill.

Royal Society of Arts, at 8.—Principal R. A. Dawson: Art Training for Industry, and the Royal Society of Art's Competitions.

Society of Chemical Industry (Chemical Engineering Group) (jointly with Institution of Chemical Engineers) (at Burlington House, Piccadilly), at 8.—J. Kwantes: The Beet Sugar Industry.

Liverpool Engineering Society (at 9 The Temple, Liverpool), at 8.—R. Waddell: The Properties and Engineering Uses of Stainless Steel.

Eugenics Education Society (at Royal Society), at 8.30.—G. C. Robson: Observations of the Selective Death-rate in Nature (Lecture).

Institution of Structural Engineers (Lancashire and Cheshire Branch), Annual Meeting.

THURSDAY, April 15.

Linnean Society of London, at 5.—Prof. C. Schroter: The Swiss National Park and Scientific Researches into its Nature (Hooker Lecture).

Royal Institution of Great Britain, at 5.15.—Prof. O. H. P. Prior: French Rhythm and English Poets in Norman and Modern Times.

Institution of Mining and Metallurgy (Annual General Meeting) (at Geological Society), at 5.30.

Child-Study Society (at Royal Sanitary Institute), at 6.—Dr. J. N. Glaister: The Educational Value of the Order of Woodcraft Chivalry.

Optical Society (at Imperial College of Science and Technology), at 7.30.

FRIDAY, April 16.

Royal Society of Arts (Joint Meeting of the Indian and Dominions and Colonies Sections), at 4.30.—Lieut.-Gen. Sir W. T. Furse: The Work of the Imperial Institute.

Institution of Mechanical Engineers, at 6.—W. Worby Beaumont and L. N. Burt: Modern Development of Paper Mill Plant.

Royal Photographic Society of Great Britain (Pictorial Group), at 7.—R. T. Gibbon: Some Limitations of Photography.

Photomicrographic Society (at 4 Fetter Lane), at 7.—Prof. R. T. Hewlett: Neurotropic Viruses.

Junior Institution of Engineers, at 7.30.—T. L. Allison: Automobile Lighting, Starting, and Ignition.

Royal Institution of Great Britain, at 9.—Dr. A. W. Hill: The Quest for Economic Plants.

Society of Dyers and Colourists (Manchester Section).—F. M. Rowe, E. Levin, A. C. Burns, J. S. H. Davies, and W. Tepper: A New Reaction of certain Diazo-sulphonates derived from β-naphthol-1-sulphonic acid.

SATURDAY, April 17.

North of England Institute of Mining and Mechanical Engineers, at 2.30.

Royal Institution of Great Britain, at 3.—Dr. W. T. Calman: The Shipworm (1).

CONFERENCE.

April 17 and 18.

Society for Experimental Biology (at Marine Biological Laboratory, The Hoe, Plymouth):—Saturday, April 17.—10 a.m. to 1—W. H. Pearsall, J. T. Saunders, B. W. Keen: Symposium: The Regulation of the Environment and its Effect on Plants and Animals. 2.15 to 3.45—E. M. Delf: Some Aspects of the Ecology of Marine Algæ.—A. D. Cotton: Ulva and the Assimilation of Nitrogen.—M. Knight: An Analysis of the Algal Vegetation of the Port St. Mary Coast, I.O.M. (Demonstration); 3.45 to 4.45, Exhibits—C. M. Yonge: Digestive Mechanisms in Mollusca.—G. P. Wells: Contractile Tissues of *Holothuria nigra*.—O. D. Hunt: Studies on Bottom Deposits of the Sea.—F. S. Russell: Plankton Distribution.—H. W. Harvey: Nitrates in Sea Water.—A. Westbrook: Tetraspore Formation in Red Algæ.—M. Knight: Ecological Photographs of Algæ; 4.45 to 6.15—F. S. Russell: Factors affecting the Vertical Distribution of Plankton.—H. P. Hacker: The Grouping of Species into Faunæ.—Sunday, April 18.—4 to 7.—C. M. Yonge: The Crystalline Style in the Mollusca.—G. S. Carter: On the Control of the Velar Cilia of the Nudibranch Veliger.—L. E. Bayliss: Contractility in Plain Muscle.—A. S. Parkes: The Mechanism of the Œstrus Cycle.

CONVENTION.

April 12 to April 17.

Optical Convention (at Imperial College of Science and Technology):—Monday, April 12.—At 12.—The Right Hon. Stanley Baldwin: Opening of the Convention; at 3.30—Sir Frank Dyson: Presidential Address.—Tuesday, April 13.—At 10 to 1 and 2.30 to 5.—Reading and Discussion of Papers.—Wednesday, April 14.—At 10 to 1 and 2.30 to 5.—Reading and Discussion of Papers; at 5.30—C. R. Darling: The Optical Lantern as an aid to Teaching (Lecture); at 8.30—Prof. G. Elliot Smith: The Eye and its Functions (Address).—Thursday, April 15.—At 10 to 1 and 2.30 to 5.—Reading and Discussion of Papers; at 5.30—W. Taylor: The Manufacture of Optical Elements (Lecture); at 8.30—J. R. Wharton: Lighthouses and the Optical Apparatus used in them (Lecture).—Friday, April 16.—At 10 to 1 and 2.30 to 5.—General Meeting for the Reading and Discussion of Papers; at 4.30—Dr. E. E. Fournier d'Albe: The Optophone (Lecture); at 8.30—Prof. A. S. Eddington: The Largest and Smallest Stars (Address).—Saturday, April 17.—At 10 to 12.—Reading and Discussion of Papers; at 12—Concluding General Meeting.

CONGRESS.

FRIDAY, April 16.

Congress of the Incorporated Association of Hospital Officers (at Central Hall, Westminster).—Miss R. E. Derbyshire: The Nursing Requirements of a Modern Hospital.—E. W. Morris: The Geographical Distribution of Hospitals in Relation to Community Requirements.

EXHIBITION.

April 12 to April 27.

International Forestry Exhibition (at Milan).

INTERNATIONAL MEETING.

April 16 to April 20.

International Society of Medical Hydrology (Annual Meeting will be held in Czecho-Slovakia). (Particulars from Dr. E. P. Poulton, at 36 Devonshire Place, W.1.)

SATURDAY, APRIL 17, 1926.

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Constitution of the University of London.[1]

THE Royal Commission on University Education in London—the "Haldane Commission"—was appointed in 1909 and its final report was issued in 1913. In August 1913 a Departmental Committee was appointed to report as to the steps by which effect should be given to the scheme of the report of the Royal Commission, but that Committee abandoned its labours soon after the outbreak of War.

The Departmental Committee, which reported last month, was set up in October 1924 with Lord Ernle as chairman. In February 1925, however, Mr. Hilton Young was appointed chairman on Lord Ernle's retiring for reasons of health. The terms of reference to the Committee were:

> "To consider the Final Report of the Royal Commission on University Education dated 27th March 1913, and, having regard to present circumstances and after consultation with the persons and bodies concerned, to indicate what are the principal changes now most needed in the existing constitution of the University of London and on what basis a Statutory Commission should be set up to frame new Statutes for the University."

In the introductory section of the report the Committee expresses high appreciation of the analysis and of the ideals presented by the Haldane Commission, but says:

> "A careful examination of the Haldane Report and the knowledge which we have acquired of the progress and development of the University, particularly since the war, have led us to the conclusion that it would be impracticable to attempt to give effect to some of the major recommendations of the Commissioners. There are other recommendations which require modification to meet altered circumstances, and there are others, again, which the University has substantially adopted. . . . We conceive our terms of reference as conferring on us the duty of devising an immediately practicable scheme for the better government, organisation and development of the University to which effect may be given by way of a Statutory Commission, and we are convinced that with the lapse of time and material change of circumstances some of the main recommendations of the Haldane Report have lost their force, and that the ground for attempting to impose such an entirely new constitution on the University as the Report proposed no longer exists. A practicable scheme of reform and reorganisation must, in our opinion, be evolutionary rather than revolutionary and build as far as possible on existing foundations. Certain characteristics peculiar to the University of London have become firmly established, the University has developed greatly during the past twenty-five years, even though hampered by serious constitutional defects. For the removal of those defects we are obliged to recommend some fundamental changes."

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[1] Board of Education: Report of the Departmental Committee on the University of London. Pp. 76. (London: H.M. Stationery Office, 1926.) 1s. 3d. net

Approaching the problem in the spirit indicated by these passages from the report, the Committee has found it possible to present, in a relatively short report, its own reasoned views and recommendations, together with a discussion of the main points on which divergent views were submitted to it in oral or written evidence. The Committee confined its attention to broad constitutional issues; thus the question of where and how the central offices of the University should be housed—rather a prominent question at present—did not call for consideration by it.

The subject of the external side was considered early, and after discussion and inquiry of the value of the examinations for external students, the conclusion was reached that, "in the view of the whole Committee these examinations have in the past served, and will in future serve, a useful purpose." It is gratifying to learn that on the evidence before it the Committee noted with satisfaction the steady growth of understanding, interaction, and good feeling between the internal and external sides of the University.

Another section of the problem before the Committee—the question of incorporation—appeared, when examined closely, to present no serious difficulty. There are two, and only two, "Colleges incorporated in the University"—University College and King's College. The Haldane Commissioners were of opinion that incorporation should be extended. The Departmental Committee, with the history of thirteen more years on the table, does not recommend the incorporation of other colleges; at the same time it does "not urge the disincorporation of University and King's Colleges." The view is that colleges should "have liberty in agreement with the University to achieve either disincorporation or incorporation."

The pregnant chapters in the Report are those headed, respectively, "The University and its Colleges," "Finance," "The Government of the University," and "The Schools of the University." In these the Committee discusses the facts and considerations which have determined its recommendations as to certain changes in the constitution of the University. These chapters give an attractive, clear, terse and pointed account of the present position and of the advantages which the changes recommended are designed to secure. That account should be read as a whole, for the proposed constitution must be fully envisaged before its effectiveness can be estimated, and the objection or difficulty which may seem to affect it at one point may, in practice, be ruled out at another.

In due course the general scheme recommended as for the guidance of a Statutory Commission will no doubt be subject to criticism and suggestion. Indeed, on a point of primary importance—the only matter of divergence within the Committee—one member of the Committee has presented a 'minority report,' and on that point readers of the main report have in its text the grounds upon which all the other members of the Committee based their recommendations.

The recommendations of the Committee are summarised under twelve heads: (1) The Council, (2) The Senate, (3) Standing Committees of the Senate, (4) The Academic Council, (5) The Council for External Students, (6) The Collegiate Council, (7) The University Extension and Tutorial Classes Board, (8) The Matriculation and Schools Examinations Board, (9) Faculties and Boards of Faculties, (10) Schools of the University, (11) Examinations, (12) The Principal.

Of these, No. 6 would give effect to the view that the "Institutional Element of the University is sufficiently important and distinct to justify not only representation on the Senate, but also the creation of a special standing committee of the Senate." This committee, designated "The Collegiate Council," would consist of the Vice-Chancellor, the Principal, the seven members of the Senate appointed by seven named institutions, the two members appointed by the Medical Schools, with possible additional members added by the Senate as representatives of institutions or groups of institutions, the Principal of the University to be chairman of the Collegiate Council.

Recommendation No. 12 includes that the Principal

> "shall have unrestricted rights of attendance and speech at all meetings of the Council [of the University], the Senate and the standing committees of the Senate, and it shall be his duty to assist them with his advice. He shall be Chairman of the Collegiate Council but he shall not be a member of the governing body of any School of the University."

It is not to be anticipated that these proposals will elicit any serious questioning, but the position, powers, and constitution of "The Council of the University," summarised in Recommendation No. 1, and the matters of policy and of administration which are set out in the Report as in relation to that recommendation, are sure to be subjected to searching examination. Recommendation No. 1 is therefore quoted here in full:

> "There shall be a Council of the University consisting of:—The Chancellor, the Vice-Chancellor, the Chairman of Convocation, Six members appointed from their own number by the Senate, Four members appointed by the Crown, Two members appointed by the London County Council, One member co-opted at the discretion of the remainder of the Council.
>
> "The Council shall control the finance of the University, and in particular it shall have final authority in the allocation of university funds, but in dealing with financial matters directly affecting educational policy it shall give the Senate a full opportunity of reporting.

> "The Council shall have power to negotiate with, and receive money from, grant-giving bodies on behalf of the University as a whole and of any of the Schools of the University including the Incorporated Colleges.
>
> "The Council shall appoint a Chairman from its own number."

With this should be read from Recommendation 2: "The Senate":—

> "The Senate shall elect the Vice-Chancellor. . . .
>
> "The Senate, subject to the financial decisions of the Council, shall control the educational work of the University, but it shall have power to delegate the performance of such duties as it thinks fit to its standing committees and other bodies."

In his minority report, Mr. Lees-Smith presents objections to the constitutional position of the Council as recommended by the Committee, and he recommends "that the representative Senate should be supreme in finance as in other fields, but should have a statutory 'Finance Council,' with the same membership as that proposed in the Report for the supreme University Council."

The recommendations which the Committee makes as to the constitution commend themselves at sight on the ground—a ground, however, to which the Committee does not refer—that the proposed allocation of functions follows in the main the lines that have proved satisfactory in all the newer universities of England and in all those of Scotland. The Report itself presents discussion, explanation, and argument which leave little strength in the objections that witnesses put to the ideas which the Committee had formulated as the inquiry proceeded.

It must be recognised that any argument from the success of corresponding schemes in other British universities does not really carry far; for in size and in complexity the University of London is *sui generis*. As to *size*: from the latest statistics published by the University Grants Committee it appears that, excluding Oxford and Cambridge from the totals, the London institutions comprised in the University of London had of full-time students 8955, while all other university institutions in England had 11,672. Of part-time students London had 7442; other institutions in England 3324. Again, the recurrent grants made by the University Grants Committee were: to London institutions, 376,270*l.*; to others in England, 386,800*l.* As to *complexity*, the Report of the Committee says:

> "There are now 38 Schools of the University ranging from large colleges with several hundreds of internal students to small institutions with few or no internal students and including on the one hand colleges providing undergraduate instruction in nearly all the staple subjects of a normal undergraduate curriculum, and on the other institutions, or departments of institutions devoted entirely to postgraduate study or research in a limited range of subjects."

The recommendations of the Committee mean that the whole amount of the grants made by the University Grants Committee and by the London County Council in respect of constituent institutions of the University would be passed in block to the council of the reconstituted University for distribution as the council might decide. Thus in this important matter the proposed University Council would bear a responsibility with which that now resting on the council of any provincial university in England is as little comparable in scale as it is in complexity. It is to be noted, however, that as the Committee has pointed out, at several stages, not only before the determination of this block grant but also during its currency, the Council of the University would be in effective communication with the University Grants Committee, and further, that in "dealing with financial matters affecting educational policy the Council shall give the Senate a full opportunity of reporting." It might well be also that the smooth starting of the proposed new constitution would be effectively aided in practice by the observations with which the University Grants Committee announced its grant to the Council of the University.

The Committee appears to have tackled successfully the problem of presenting, in outline, a reasoned scheme for such amendment of the constitution of this great University as would provide machinery for its government and administration, sufficiently well-knit to avoid waste of effort, and sufficiently flexible to adapt itself to work in the varied fields in which the University operates.

There are, however, some considerations which, if not faced before effect comes to be given to the recommendations as a whole, may prove detrimental to the scheme. These turn on the fact, which is fully recognised by the Committee, that "the University on its teaching side is organised mainly on a collegiate basis." It is in this collegiate basis of its parts that the University of London differs essentially from the newer universities of England. The resources of its schools are in varying degree in the form of buildings, endowments, and fees and other income liable to fluctuation. A large part of the fluctuating income comes from the grants, national and local, which in the case of London the Committee recommends should be paid in block to the University for allocation to its colleges and other schools. Now, some of these institutions perform valuable functions which are not regarded as university work; many of them have received, both for their university work and for their other activities, valuable annual support and liberal endowments from donors more appreciative of specialised work than of the far-flung usefulness of the University. Not a little of this support has been given for work that is definitely university work but in particular institutions. Considerations turning on such facts as these are bound to give rise to ideas, and indeed fears, that would retard the development of the institution which the Committee desires to promote.

Relatively well-endowed or well-supported schools of the University may fear that the payment of grants in block for allocation within the University may in practice to some extent discount the benefits of their separate resources. Prospective benefactors may find in it reason to hesitate to be generous to a particular institution or in respect of particular aims which they desire to forward.

With the University in the hands of a well-constituted Council and Senate, such fears or hesitation should not materialise; but now is the time to prevent harm from their emergence. The Committee has aimed at an evolutionary rather than a revolutionary scheme of reform and reorganisation. Well-judged application of public support has been the dominant element in the environment of the several institutions of the University, and there should be no apparent risk of serious change or unsettlement in this influence. Some reassurance on this matter appears to be desirable, and it would be well that national and local grants continued to be at least earmarked in the initial stages of the proposed changes. Even now the list of recurrent grants made by the University Grants Committee shows that, in the case of provincial university centres, separate grants are made to six colleges—five in England and one in Scotland—each presumably doing good university work for its region although not incorporated in the university.

Italian Alchemical Manuscripts.

Sulle fonti storiche della chimica e dell' alchimia in Italia. Per Dott. Giovanni Carbonelli. Tratte dallo spoglio dei manoscritti delle biblioteche con speciale riguardo ai codici 74 di Pavia e 1166 Laurenziano. Pp. xix+218. (Roma: Istituto Nazionale Medico Farmacologico, 1925.) 300 lire.

THE great libraries of Italy form one of the happiest hunting-grounds for the seeker after ancient alchemical manuscripts. Dr. Ernst Darmstaedter's exciting discovery last year of a Latin version of Geber's "Book of Mercy," up to that time known only in its Arabic dress, is almost certainly merely a foretaste of what is to come. In the practically unbroken tradition of culture in Italy, extending over a couple of millennia, the accumulation of precious documents has found a peculiarly favourable atmosphere, and the International Committee which is now conducting a census of alchemical manuscripts in Europe will doubtless unearth its greatest treasures in the land of Dante—who consigned all alchemists to a special corner of the Inferno.

The part played by Italy in the scientific renaissance of the twelfth and thirteenth centuries and in the transmission of knowledge has scarcely received the recognition which is its due. In South Italy and in Sicily, under the Norman sovereigns, the translation of scientific works and the dissemination of learning went on apace; in Sicily, for example, the "Almagest" appears to have been translated for the first time into Latin from the original Greek, in 1160 or thereabout, while on the practical side it has been suggested with every probability of truth that the discovery of alcohol was made in South Italy in the tenth century. Although conditions in the northern portions of the country were not so favourable, the commercial relations between Venice and Pisa and various regions of the East led to the establishment of Italian colonies in Constantinople, and in this and other ways a transmission of knowledge and a steady intercommunication between scholars was rendered possible. Among the translators of the north of Italy may be mentioned Burgundio of Pisa, who translated ten books of Galen, and Pascalis Romanus, who, says Prof. C. H. Haskins, can be "almost certainly identified with the translator from the Greek, in 1169, of the curious book known as the Kiranides."

There is, therefore, every reason for great expectations from the Italian manuscripts, and particularly so when we recollect that Italy is also the home of painting. The Muslim dislike of representations of anything endowed with life reacted upon the illustration of books, with the result that very few figures of any sort are found in Arabic alchemical manuscripts; while in most of Europe the alchemists do not shine conspicuously as artists. Such delightful drawings as those which are found in a British Museum manuscript of the "Ordinall of Alkimy," by the Bristol alchemist Thomas Norton, are noteworthy as much for their rarity as their beauty, while in the printed books the figures of apparatus do not often reach the level of those in the 1545 Geber.

With our appetites thus whetted we may turn to Dr. Carbonelli's sumptuous volume and sample his fare. Our first impression is one of complete satisfaction, for it is produced by the sight of his numerous and very attractive illustrations. The coloured frontispiece is a reproduction of Giovanni Brueghel's picture entitled "Elemento del Fuoco," which was probably painted in 1608 for the Cardinal Federico Borromeo, and shows a variety of chemical reagents and apparatus. The muffle in the centre of the picture would not look at all out of place in a modern laboratory, while the bottle of mercuric oxide occupies a position ominous of its future importance. Of the other illustrations we can refer to only a few. Those which offer the greatest appeal are Andrea Orcagna's fresco of the "Alchimisti e falsificatori" in the Tenth Bolgia of Hell, and the drawings of apparatus on pp. 133 to 138. There are also hypothetical portraits of Hermes, Geber, Avicenna and Galen, and a beautiful illuminated page from a manuscript of a work by Albertus Magnus. Altogether there are 242 photographic reproductions, splendidly executed and admirably selected, and for these alone the book is well worth the comparatively modest price asked.

When we leave the illustrations and turn our attention to the letterpress, our first impression of satisfaction will probably wear off. Dr. Carbonelli has unfortunately chosen to make excerpts from the manuscripts and to connect them up into a narrative. The effect thus produced upon the reader is one of exasperation, who either finds himself cut off in the course of a most interesting passage from the manuscript or else is suddenly plunged from Carbonelli into the middle of a treatise of the beginning of which he knows nothing. In spite of this regrettable habit, however, the author has succeeded in making his book attractive by his unerring instinct for the curious and unusual; perhaps no other book on alchemy in recent years has provided such varied and stimulating material. Thus, in Section IV., Dr. Carbonelli describes certain magical and alchemical manuscripts written on lead and silver. At Florence there is a manuscript of this kind, consisting of nine leaden leaves, pierced with two holes and held together by two cords and a little rod of lead. The writing is of the first half of the sixteenth century. On the first page, in Gothic letters, is inscribed: *Benedicta lapidem* (sic) *prima materia est.* Below is an equilateral triangle, and below that again the following phrase: *Ego sum Ambagasar quo dabo a tibi veri secretum secretissimum noster.* In the remaining leaves many of the well-known alchemical sentences occur, such as *Mercurius noster non est mercurius vulgi*, and *In rerum multitudine ars nostra non consistit.* Directions are given for preparing the elixir, which, in addition to its power of transmutation, will cure any incurable disease, "so that you may eat and live a long time upon the earth—supposing, that is, that you observe the Divine Laws."

A very valuable feature of the book is the inclusion at the end of several glossaries of alchemical names, extracted from manuscripts in the author's possession and elsewhere. The number of Arabic terms carried over bodily into medieval European alchemy is astonishing, and the corruption which they have undergone in many cases renders them almost unrecognisable in the absence of glossaries. Knowing, for example, that *leserab* means lead, it is not difficult to see that this word is a corrupt rendering of *al-usrub*, and when *anthigar* is said to signify borax, one can easily trace the derivation from *al-tinkar*; but it is doubtful if these and similar words could have been identified—at least with certainty—in the absence of a vocabulary.

As a whole, Dr. Carbonelli's book reminds us of a shop-window filled with the most attractive wares; we are fascinated by the treasures exposed, but we want to take them out of their setting and examine them carefully one by one and put them in a more suitable environment. Any chemist who feels that he cannot afford to give 300 lire for a book must on no account look at it, or he will inevitably break all resolutions of economy; if he does not succumb until p. 116, the double-page drawings there will certainly complete his downfall.

E. J. Holmyard.

The Winning of Petroleum.

Oil-Field Exploration and Development: a Practical Guide for Oil-Field Prospectors and Operators; with which is Incorporated a Discussion of the Origin and Distribution of Petroleum, and Notes on Oil-Field Legislation and Customs. By A. Beeby Thompson. In 2 vols. Vol. 1: Oil-Field Principles. Pp. xxiv + 546 + 32. Vol. 2: Oil-Field Practice. Pp. xxiv + 547-1177 + 32. (London: Crosby Lockwood and Son, 1925.) n.p.

The subject of oil-field engineering is a difficult one to deal with in a radical manner within the space of two volumes, but whatever Mr. A Beeby Thompson's work may lack in this respect is more than compensated by the amount of information it contains. Whilst we may not have a great deal to learn from America in regard to the geological and refining branches of the petroleum industry, there is no doubt that oil-field practice there is considerably ahead of that adopted by British oil-field engineers. It is a little disappointing to find, therefore, that the author, who is as well acquainted with American drilling methods as the practice of other fields, has added very little to the information given in his earlier books on the subjects of drilling, fishing, and water exclusion.

In the first volume, more ground has been covered, in dealing with oil-field principles, than one would deem possible in the space available. The work of many investigators, augmented by the practical experiences of the author, has been brought to bear on the problems under discussion, but the arguments are inconclusive.

The chapter dealing with the origin of oil is well written, and the many theories advanced have been treated with great care. The formation of oil-fields makes interesting reading, but we would wish the portion dealing with the causes of oil-field pressures had been treated in more detail.

Whilst there are many books on geology, few of them deal with that portion of the science which is applied to the location and winning of petroleum, and the sound, practical hints on oil-field mapping, together with the chapter on oil-field structures, should prove of extreme interest and value to the student and beginner in this branch of the industry. The important bearing which surface indications have on such work is exemplified in detail, particularly in regard to mud volcanoes, petroleum seepages, asphaltic deposits, and the general association of sulphurous and saline waters with petroliferous areas, but the conclusions to be drawn from such indications are dismissed in a very few pages.

Much valuable information is brought together within a small compass in the chapters which concern the geology of the various oil-fields throughout the world. Particulars of many of the fields given have not been available in book form hitherto. These chapters are undoubtedly the best in the first volume. The book has been written as "a practical guide for oil-field prospectors and operators," and we feel that the chemical and physical properties of natural hydrocarbons are not dealt with in a sufficiently fundamental manner to serve the purpose intended. In the refining portion, the author deals with the effect of open steam and vacuum distillation clearly, but beyond describing briefly one continuous method of distillation, the reader is left with the impression that the distillation and refining of petroleum generally is a comparatively simple matter.

Errors which should be corrected in any future edition are the reference to the Edeleanu process and to the use of adsorptive materials for the purpose of refining, as being chemical methods; and the reference to cracking in the vapour phase as a commercial proposition. We feel this portion of the book scarcely does justice to the author or those engaged in the refining branch of the petroleum industry.

The second volume, on oil-field practice, is appreciated all the better for keeping until last. The descriptive matter relating to the various methods of oil-well drilling and lining contains much information, notable features being the Hild differential gear for controlling and maintaining torsion on the 'rotary' stem below an arbitrary limit, and a short reference to coring. The specifications for the different types of drilling outfits should prove of use to the field-man.

One point stressed by the author will receive the approbation of all production engineers of experience, namely, the present necessity of employing the services of scientifically trained junior geologists for the collection, examination, and description of samples of the formation passed through. "The driller's phraseology no longer conveys as much information as modern research demands."

Methods of recording and analysing drilling and producing records, not only for immediate use, but also for estimating purposes in the future, and the tabulated drilling costs on various oil-fields, particularly those of recent date, are some of the outstanding features of this volume.

The havoc wrought in many fields through overlying and lower waters entering oil-sands, and how this might be obviated by adopting a uniform casing programme throughout the field, is clearly shown with the aid of a diagram, and is worthy of note by men of experience. Attention is also directed to the danger to casing, in position, of corrosive waters, and also to the importance of chemical analyses of oil-field waters with the view of their identification. These chapters, together with those dealing with the location and isolation of oil-field waters and the various methods employed for the recovery of petroleum, which comprise the bulk of the second volume, prove the author to be a man of wide experience in methods of production. His experiences confirm the opinion shared by many petroleum technologists of experience that the responsibilities of the production superintendent are as great as, if not greater than, those of the drilling superintendent.

Mr. Beeby Thompson's views on oil-field equipment, particularly where internal combustion engines and electric power for oil-field purposes are dealt with, are welcome in literature of this kind, as the application of electricity to production work is still in its infancy. With the necessity for housing oil-field workers in comfortable and sanitary camps, particularly in the tropics, every one will agree, and valuable suggestions are made with this in view. More space might have been devoted to the Chambeau system of sewage disposal for the benefit of those situated in isolated places who are unfamiliar with sewage problems generally, and this simple, but effective, method in particular.

Useful information concerning the design of pumping plant and frictional losses in oil pipe-lines is included, and the chapter on natural gas gives a clear insight into the methods of casing-head gasoline absorption and gas transmission. The work is completed by an appendix giving tables and data which all petroleum technologists will find useful.

As a compilation of facts and knowledge augmented by the personal experiences of the author, the work can be recommended especially to petroleum students and those about to enter the industry, as it deals largely with information of a practical character which scarcely comes within the purview of an academic teacher on the subject, and many of the chapters will prove of interest to the production engineer of experience. The book is well illustrated, and those desirous of pursuing further any of the questions under discussion will find ample and complete references.

Alfred W. Nash.

The Smoke Problem.

The Smoke Problem of Great Cities. By Sir Napier Shaw and Dr. John Switzer Owens. Pp. xvi+301. (London: Constable and Co., Ltd., 1925.) 22*s.* 6*d.* net.

It is a significant fact that the thing which first strikes the foreigner on visiting large cities in Great Britain is the smoky atmosphere and the grimy appearance of the buildings. He wonders how we can tolerate such an environment. It is true enough that most of us do so, and it may be, as one writer has said, "that thousands of people live their lives from start to finish in the midst of black smoke and have come to regard it as a normal condition of life." Nevertheless, there is a small section of the community who feel very differently on the subject, as the growing mass of literature on the smoke nuisance testifies. The latest contribution is a treatise on the smoke problem of cities by Sir Napier Shaw and Dr. Owens, who for many years have devoted their attention to the estimation of atmospheric impurities in London and other large towns. The most interesting section of the volume is the record of these experiments, namely, the measurements by the standard gauges, which have been set up in various towns, and the results obtained with the dust filter and the jet dust counter, all of which have already appeared *in extenso* in the reports of the Committee on Atmospheric Pollution of the Meteorological Office. The volume includes also a good deal of information borrowed from other sources.

The standard gauge consists of a circular stoneware funnel of 30 cm. diameter, which is inserted into the neck of a large bottle, and the solid deposit which is carried down by rain or blown in by the wind is estimated at stated intervals throughout the year. The character of the deposit varies considerably in different towns, and will naturally depend on the situation of the gauge and the rainfall. For example, the deposit at Malvern, a residential town in a rural district, contains so much as fifty per cent. of wind-blown mineral matter. The soot, amounting to eight per cent., which is estimated by the loss of weight on ignition of the deposit (and may very well contain vegetable matter), curiously enough is free from tar, although the authors find so much as 37 per cent. in domestic soot. The result, as indicative of atmospheric pollution in different towns, cannot be regarded as altogether trustworthy, and I would suggest as a more satisfactory method, the collection of the permanent tarry deposit on glass plates which could be roughly but rapidly estimated by the amount of light obscured from a standard lamp. For the tarry deposit, for which the domestic hearth is mainly responsible, is cumulative in its destructive and disfiguring effects. The free acid, another destructive agent, might also be estimated in the rain water.

There is one statement which, though probably correct, is somewhat misleading, namely, that the soot suspended in the air is not removed by rain. There is no doubt, however, that soot is absorbed by clouds, as it is by fog, and the former when resolved into rain will carry down considerable quantities of soot. Snow will do the same. The chapter on the dust filter and automatic recorder designed by Dr. Owens is one of considerable interest and importance, and probably affords a more satisfactory estimate of air pollution than the gauge referred to. It is an apparatus for filtering a measured volume of air through white filter paper and estimating by the shade of the deposit the extent of impurity. By an ingenious modification the instrument is rendered automatic, so that hourly records can be taken if necessary without supervision. The jet dust counter is a modification of Aitken's dust counter, by which particles of dust are deposited on a cover glass and can be examined microscopically. In this way some curious observations have been made on the nature of the more minute atmospheric particles.

In addition to the above, the authors have collected information on the industrial uses of smoke, on the use of different kinds of smokeless fuel, on the remedy for industrial smoke and a summary of the recommendations of Lord Newton's committee. The latter is a useful addendum; for the report has been very sparsely circulated and is now out-of-print. The book is the most comprehensive account of the subject which has yet appeared. But unfortunately its very comprehensiveness makes the price prohibitive to the ordinary individual whose co-operation is so essential, if this pestilential nuisance is ever to be seriously tackled. The following paragraph is from the recent report of the Coal Commission:

> "We would observe that the three million tons of soot which it is estimated by the Commission are discharged into the air annually are equal in weight to nearly three days' output of all the collieries of Great Britain. In effect the work of over a million for three

days every year is devoted to providing the soot which pollutes our atmosphere."

When one realises that raw coal and coke may and should be burnt in boiler furnaces without smoke, that gas-coke may replace raw coal for domestic use (I use nothing but gas-coke for hot water and heating the living-room), the production of smoke seems a criminal waste of our fuel resources, apart from the heavy cost in health, in the destruction of vegetation, disintegration of masonry and metal work, deterioration, so I am told, of valuable oil paintings, and the outlay in washing and repainting. J. B. COHEN.

Mammalian Palæontology.

Text-Book of Palæontology. By Karl A. von Zittel. Vol. 3: *Mammalia.* Revised by Dr. Max Schlosser. Translated under the direction of Dr. Charles R. Eastman by Lucy P. Bush and Marguerite L. Engler. Translation revised, with Additions, by Sir Arthur Smith Woodward. Pp. viii + 316. (London: Macmillan and Co., Ltd., 1925.) 25*s.* net.

THE completion, after twenty-five years, by the issue of a volume dealing with mammals, of that translation of v. Zittel's "Grundzüge der Paläontologie" for which the late C. R. Eastman was responsible, is creditable to its publisher, and may, we hope, be a symptom of a renewed interest in palæontology in Britain.

The "Grundzüge" is the one essential book to the working palæontologist, because it lists the great majority of genera of fossil vertebrates, indicating the more important synonyms and referring them to families. Of these families, and all larger groups, short and usually excellent diagnoses are provided; only those who have never endeavoured to draw up similar condensed statements of the characters which define groups will complain that some of the animals do not really exhibit the 'diagnostic' characters of the groups within which they are included. To these descriptions are added more detailed accounts of the structure, in the main naturally of the skeleton, and sometimes indications of phylogeny; and the book ends with an excellent general account of the distribution in space and time of the more important mammals.

The title adopted for the English edition, a "Text-Book of Palæontology," neither correctly translates the German title nor expresses the character of the book. Consisting as it does of a mass of facts with no indication either of methods of work or of the general theory of the subject, it is by itself of little use to the beginner, and requires to be supplemented in some way, either by a teacher or by some, as yet unwritten, introduction.

Of the German version, four editions have appeared, the last in 1918 and 1923, and a fifth is in preparation. The present translation, which was left nearly all in type, though unrevised, at the death of Dr. Eastman in 1918, has been to some extent brought up-to-date by Sir Arthur Smith Woodward. This long delay has, however, resulted in the omission of many important discoveries recorded in the German edition of 1923. Of these the most serious is that of all reference to the work of Dr. Pilgrim, work which is fundamental in that it gives us an understanding of the age of the successive faunas of India, and for the first time enables us to use them in discussion of phylogeny and of migration.

There are many other omissions of important finds: Broom's account of the skull of Polymastodon; Dr. Matthew's Eodelphis, Palæoryctes, Zanyrictes; Stehlin's so-called Chiromyids; Osborn's skulls of Bathyopsis and Eotitanops, all things of first-rate importance published before 1923, are not referred to. The American and Swedish work on the fossil mammals of China and Mongolia is perhaps too recent to expect. Finally, it may be pointed out that the German volume containing the lower vertebrates in addition to the mammals costs 18*s.*, whilst the two corresponding English volumes are 50*s.* D. M. S. WATSON.

Our Bookshelf.

Principles and Practice of Farm Book-keeping: a Text-Book for Agricultural Students. By Leonard F. Foster. Pp. viii + 476. (London: Gee and Co. (Publishers), Ltd., 1925.) 15*s.* net.

THE time has come when farmers and accountants must study each other's requirements, for the business of farming cannot now be conducted by the free and easy methods of the past. The farm requires special consideration in its book-keeping department, for in that, as in many other things, it differs widely from the ordinary undertakings of commerce. Farmers who have sought the aid of accountants in coping with their book-keeping problems have very often been unable to obtain that meed of help which they may have expected, because the ordinary cut-and-dried methods of account have not been varied to meet their special need. It is probable that the demand for special agricultural accountancy is only now becoming strong enough to make itself felt, and Mr. Foster's book is one of the first serious attempts by a qualified accountant to expound the principles of book-keeping as applied to the farm departments.

It is a welcome book, because there are a large number of people, students and practising farmers alike, who are looking for something of the sort. It is a good book, because it covers the subject with which it professes to deal, and develops it in easy and definite stages from the first broad principles to the special technical applications found in agriculture. It contains a wealth of illustration in the form of specimen accounts, and the method of expression used is at once clear and sufficiently human to maintain the reader's interest.

Mr. Foster is careful to state that his work does not do more than touch lightly on the subject of farm costing. The difference between financial and cost accounts is not always clearly seen by persons who are new to book-keeping. Theoretically both may be necessary to the really efficient management of a large holding, but for the immediate purposes of sound trading and daily guidance, it is the financial accounts which are so very important. It is to be hoped that more accountants will follow Mr. Foster's example and develop the subject of farm book-keeping to the mutual benefit of their rural clients and themselves.

C. H.

The Science of Soils and Manures. By J. Alan Murray. Third edition, revised and enlarged. Pp. xiv + 298. (London: Constable and Co., Ltd., 1925.) 12s. 6d. net.

THE third edition of this text-book, issued under a slight change of title, aims at bringing its subject up-to-date for the use of students of advanced university standard. The considerable recent advances in our knowledge of soil structure and chemistry, and in the bearings of soil biology on plant growth, have been incorporated, compensation of space being made by judicious omissions of certain ideas and methods which are either out-of-date or have failed to fulfil their promise of usefulness. A concession to more advanced students is made by the inclusion of pertinent mathematical data in the appendix, to which are also removed from the text various tables only required for occasional reference, whereby the handiness of the book is considerably increased.

Certain features of the work deserve special commendation. The horticultural, as opposed to the agricultural, aspect of the fertiliser problem is considered, and manurial tables are included applicable to garden crops, of which the requirements vary considerably. Attention is given to the various manufacturing processes of artificial fertilisers, with illustrations of plant actually in use, thus enabling the student to obtain a clearer idea of what he is really dealing with when applying manures. A useful chapter on fertiliser valuation is included, concrete examples being given, illustrating the misleading nature of the system of unit prices, and showing simple methods by which the actual value of fertilisers to the farmer can be calculated.

W. E. B.

Outlines of Qualitative Chemical Analysis. By Prof. Frank Austin Gooch and Prof. Philip Embury Browning. Fifth edition, revised. Pp. viii + 184. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 7s. 6d. net.

THIS work supplies a " systematic scheme of analysis " for the usual set of commoner basic and acidic ions. One would like to see these somewhat hackneyed limits extended to include a few 'rare' elements. It is difficult to know where to stop, but surely it is time that ordinary courses in chemistry dealt with such commercially important elements as, for example, titanium, molybdenum, tungsten, and possibly even thorium.

So far as it goes, the book deals excellently with the subject. An introductory chapter treats briefly but well of the ionic principles underlying the reactions; and the usual systematic examination, condensed into tabular form with commentaries on important points, is supplied with ample references to this first chapter. The methods given are well arranged and up-to-date, and a student who works carefully through them and answers the questions set should learn some chemistry as well as 'tests.' The book is marred by a final short chapter on some haphazard tests for a few commoner organic compounds—acids, alcohols, sugars, alkaloids—a chapter which, with little system and no instruction in principles, is decidedly inferior to the preceding matter.

The book is well turned out, and few printing errors have been noticed.

T. W. H.

Half-Hours with the Telescope: a Popular Guide to the Use of the Telescope as a Means of Amusement and Instruction. By R. A. Proctor. Revised and brought up to date by Dr. W. H. Steavenson. Pp. xii + 131 + 7 plates. (London: Longmans, Green and Co., Ltd., 1926.) 5s. net.

THIS is the fifteenth impression of this book since its inception in 1868. Under Dr. Steavenson's revision, a number of necessary corrections and additions have been made with the view of continuing its former usefulness. New illustrations have been substituted throughout. It may be mentioned that the book is essentially one for the amateur possessing a telescope which he is prepared to use. He will then find in this little publication an excellent guide to the many objects of interest within reach of modest telescopic means, together with a simple account of the construction of his instrument and valuable hints for its successful use. The book is of pocket size, and the type is clear. There are, however, a few misprints, as on pp. 59, 70, and 107. A brief note on the nomenclature of the stars, or a reference to the British Astronomical Association Handbook for 1924 (in which all star catalogues are briefly described), would have been helpful to the beginner. From a cursory glance at the pages, the would-be purchaser might be inclined to object to the price, but its worth will be readily admitted by a purchaser who, with its aid, has spent some very profitable half-hours with his telescope.

Sympathetic Training of Horse and Man. By Major T. S. Paterson. Pp. xi + 205 + 8 plates. (London: H. F. and G. Witherby, 1925). 12s. 6d. net.

THIS book is described as " a Handbook on Present-day Training in Equitation," and, as the title indicates, it includes the necessary training of both man and horse in the methods by which that remarkable sympathy between horse and man can be established. As the author so admirably shows, successful equitation depends on the establishment of this link. Scientifically, we may be permitted to doubt whether the material indications of intention (the rein, spur and so forth) are the true media of communication between man and horse. The manner in which the dog, too, divines his master's mind, is scarcely capable of simple explanation. A well-written and attractive book.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Spinning Electrons and the Structure of Spectra.

RECENTLY Uhlenbeck and Goudsmit (NATURE, February 20, p 264; see also *Naturw.*, November 20, 1925) have directed attention to the fact that a number of features of multiplet structure and the anomalous Zeeman effect can be described by assuming the electrons in the atom to possess an inherent magnetic moment, pictured as being due to a spinning motion of the electron about an axis of symmetry. This moment must be considered as having a magnitude of 1 or 2 Bohr magnetons (about 10^{-20} c.g.s. units), depending on what rules one assumes to govern the orientation of the axis with respect to an external magnetic field. The above-named authors discuss the advantages which such a view brings with it, but fail to point out some serious difficulties.

If it is permissible at all to use pictorial concepts such as the word 'spinning' evidently implies, it must also be permissible to speak of the 'dimensions' of an electron. These dimensions would then have to be taken as of order of magnitude 10^{-13} cm. To give a magnetic moment around 10^{-20}, the internal velocities would have to be exceedingly close to that of light. Now the elementary unit of magnetic moment, the Bohr magneton, is derived from considerations of the *orbital* motions of electrons with velocities *much smaller* than that of light (W. Pauli, jun., *Zeit. f. Phys.*, 31, 373, 1925), in which the internal structure of these electrons does not enter at all, so that they can be regarded as point charges It is hard to see, then, why this elementary unit should also be characteristic of the internal motion of the electrons in spite of the high velocities involved, and that with a precision which would have to be considerable, if the measurements on the anomalous Zeeman effect were to be explained in this way.

Quite aside from this objection, the validity of which could perhaps be questioned, since we may not be justified in applying the classical concepts of kinematics and electrodynamics to the case of the structure of the electron, even if we only wish to obtain rough estimates, the following difficulty arises. In order to account for the observed Zeeman effect by the hypothesis of Uhlenbeck and Goudsmit, it is necessary to assume that an orbital electron always has the same magnetic moment, of the order of a Bohr magneton, no matter in what orbit or in what atom. One is thus led to expect that this also remains true when an electron forms part of the nuclear structure. But then the nucleus, too, will have a magnetic moment of the order of a Bohr magneton, unless the magnetic moments of all the nuclear electrons just happened to cancel. For such an additional moment of the nucleus there is no place in the theory of the Zeeman effect, and the probability that in all atomic nuclei the magnetic moments of the electrons neutralise seems *a priori* to be very small.

The new hypothesis, therefore, appears rather to effect the removal of the family ghost from the basement to the sub-basement, instead of expelling it definitely from the house. R. DE L. KRONIG.

Columbia University,
New York.

Theories of Adsorption and the Technique of its Measurement.

SEVERAL years of measurement of sorption in the University of Bristol laboratory by the simple and searching method of the sorption balance (for description see *J. Am. Chem. Soc*, 1924, 46, 2781, and March 1926, 48, 690) have taught us two things: First, most of the published data on the sorption of gases and vapours possess no quantitative significance because they refer to insufficiently cleaned surfaces. Second, the behaviour of a surface when cleaned from pre-existing impurities assumes a different and highly significant form It is usually supposed that mere heating of a substance like charcoal to, say 400°, with exposure to an ordinary vacuum, will completely remove previously sorbed gases. This is by no means the case. For example, carefully prepared sugar charcoal, which had been activated by superficial oxidation at about 1200°, was given an exposure for five hours at 450° to a vacuum of 10^{-6} mm, and was afterwards found to sorb a maximum of 17·5 per cent. of its own weight of nitrous oxide in a protracted series of experiments. The amount of nitrous oxide sorbed was raised to no less than 26·5 per cent. by the simple expedient of re-evacuating the charcoal at 450° after its saturation with nitrous oxide, and then repeating the measurements. Similar behaviour has been observed in many other cases; for example, the observed sorption of such inert substances as hexane or decane may be increased several fold by repeating the evacuation after the charcoal has been saturated with the hexane or decane to displace other impurities from the surface

It is evident that published data are too uncertain in magnitude to permit of accurate comparison of the sorption of various substances for the testing of conflicting hypotheses. The second influence of these neglected residual impurities is to change the character of the curve representing the dependence of the sorption upon the pressure or vapour pressure The ordinary form of sorption curve as obtained in the presence of tenaciously sorbed impurities shows steady increase with increase of pressure. The same surface when cleaned gives not only much greater sorption, but also the sorption is practically complete at comparatively low pressures, remaining constant at a saturation value as the pressure is further increased. With methyl alcohol and with toluene, for example, the pressure of the vapour can be increased five to twenty fold without appreciable increase in the amount adsorbed once the saturation value has been attained Moreover, the adsorption on clean surfaces is nearly instantaneous and is perfectly reversible. It therefore becomes evident that the existence of a saturation value for sorption of vapours by charcoal is normal and characteristic.

There are at present three competing theories of adsorption: First, the monomolecular films of Langmuir (1916), Henry (1922), and others, in which interaction is confined to molecules of gas or vapour in actual contact with molecules of the surface; second, the polymolecular films of Polanyi (and Williams, *Proc. Roy. Soc.*, A, 1919, 96, 307) and Lamb and Coolidge (1920), where it is assumed that at distances many molecular diameters away from the solid surface, there is still a powerful attraction of gas or vapour molecules towards the surface, producing a film of compressed gas or even liquid; third, the capillary condensation hypothesis of Gurwitsch, 1915, and Patrick, which assumes that liquid is condensed in bulk in the pores of a porous solid such as charcoal or silica gel.

The objections to the Gurwitsch-Patrick hypothesis as a general theory are that it ignores the existence of adsorption upon plane non-porous surfaces, and that it does not account for the adsorption of the layer of molecules of liquid in actual contact with the solid. Furthermore, calculation from the well-known thermodynamic formula connecting vapour pressure with pore diameter for a liquid in a capillary shows that the greater part of adsorption is observed at pressures so low as to correspond with pores of diameters comparable with molecular magnitudes. Hence, even from this, one may argue that here true adsorption is responsible because the adsorbed molecules are all in direct contact with the molecules of the surface. Of course, whenever a surface coated with a mono-molecular film is shaped as a pore and exposed to nearly saturated vapour, liquid may condense in such a capillary.

The evidence for the thick compressed film of Polanyi is weak. The unknown constants of the formulæ based upon the assumption of a multimolecular film are determined by using some of the actually measured sorption data; and the expression then fits the remaining sorption data at other temperatures, etc. However, any one of the other theories will do as much. Again, many experiments have shown apparently thick films, but only with materials such as tarnished metals, glass that had been washed out with water, etc., where the true surface was unknown. Williams's derivation indirectly led to a determination of the thickness of the adsorbed layer; and he found from his study of existing data for gases and vapours that the thickness was of molecular magnitude except in the case of charcoal exposed to saturated vapour of liquid argon, where alone it corresponded to several molecules thick. Further, Henry's formulæ for monomolecular films are closely similar to those of Williams.

Much direct evidence has been brought in support of the monomolecular film hypotheses. The films postulated differ greatly in respect of packing, relation to the structure of the solid, nature of the binding force, whether truly chemical or due to physical forces or residual valency, etc., but they are alike in explaining all forms of adsorption as due to direct attachment of the adsorbed molecules to the solid surface. The striking fact that in our normal sorption curve the adsorption is practically completed at relatively low pressure affords new and almost conclusive support for the hypothesis of a monomolecular film.

JAMES W MCBAIN.

University of California,
Berkeley, March 19.

Abraham de Moivre.

IN interesting and valuable communications to *Biometrika*, of the final issues for 1924 and 1925, Karl Pearson set forth certain facts (not all new) which will doubtless result in Abraham de Moivre occupying a more important place than before in the history of mathematics. The results are reached by a careful study of: (*a*) "James Bernoulli's Theorem," and (*b*) a publication of Moivre dated November 12, 1733 Regarding this publication Pearson makes certain statements which require comment, since from them wrong inferences might readily be drawn.

This publication is entitled: "Approximatio ad Summan Terminorum Binomi $(a+b)^n$ in Seriem expansi" and was found bound in with one copy of Moivre's "Miscellanea Analytica," 1730. Pearson remarks:

"Many copies of this work have attached to them a *Supplementum* with separate pagination, ending in a table of 14 figure logarithms of factorials from 10! to 900! by differences of 10. But only a *very few* copies [P. tells of only the one] have a second supplement, also with separate pagination (pp. 1-7) and dated Nov. 12, 1733. This second supplement could only be added to copies sold three years after the issue of the original book, and this accounts for its rarity. Dr. Todhunter in writing his *History of the Theory of Probability* appears to have used the 1730 issue of the *Miscellanea Analytica*, and so never came across this supplement."

Pearson here seems to make two slips: (*a*) in assuming that because this "second supplement" is bound at the end of a copy in the University College Library, it was really a second supplement, (*b*) in stating that this publication was not considered in Todhunter's "History." As a matter of fact, this 'second supplement' appeared in English, except for minor changes, in both the second and third editions of Moivre's "Doctrine of Chances," 1738 and 1756. Todhunter considers this on pages 184, 192, 193 of his "History." Curiously enough, in the latter part of his first article, after having indicated the results of the 'second supplement,' Pearson remarks: "The same matter is dealt with twenty-three years later in the edition of 1756 of *The Doctrine of Chances*, pp. 243-250. Todhunter in his *History of the Theory of Probability*, Arts 324 and 335, passed over the topic most superficially." Did Pearson overlook that a translation of his 'supplement' was thus dealt with in 1756 by Moivre and in 1865 by Todhunter? That this translation appeared also eighteen years before was manifestly not recognised.

Moreover, Moivre prefaces his translation with the statement (which Todhunter quotes): "I shall here translate a Paper of mine which was printed November 12, 1733, and communicated to some Friends, but never yet made public, reserving to myself the right of enlarging my own thoughts as occasion shall require." Hence it is clear that the publication in question was not a 'second supplement' to Moivre's "Miscellanea Analytica," but was first 'made public,' and in English, in 1738. A facsimile of this pamphlet is to appear in an early number of *Isis*. It would be interesting to learn if any other copy of Moivre's original pamphlet is in existence.

RAYMOND CLARE ARCHIBALD.

Brown University,
Providence, R.I.,
February 22.

I am glad that Prof. Archibald's letter enables me to return to the subject of De Moivre's claim to be the first discoverer of the normal curve of errors usually attributed to Laplace or Gauss.

I do not think from what Prof. Archibald has written that he can have seen what he thinks—and possibly may be—the unique copy of the "Approximatio ad Summan Terminorum Binomi." It is in the same type and has the same characteristic species of tailpiece as the "Miscellanea Analytica." It has the same unusual form of pagination as the first "Supplementum", it is printed on the like paper and is of the same format as the first "Supplementum" and the "Miscellanea" About half the known copies of the "Miscellanea Analytica," have *not* the first supplement, and I think it quite probable that the "Approximatio" was only bound up with a few last copies of the "Miscellanea Analytica" issued after November 1733. At any rate, that is where I should seek for it *first*. I said in my paper that De Moivre treated of the same matter in his "Doctrine of Chances," 1756, because that was the edition I was working with. Prof. Archibald rightly says that it was also treated of in the 1738 edition, and then speaks as if the matter in the 1738 "Doctrine of Chances" and again in the 1756 edition was a mere translation "except for minor changes." This is not correct; for the history of statistics most important additions were made in both the 1738 and 1756 editions. The important principle of the 'activating deity' maintaining the stability of statistical ratios does not occur in the 1733 "Approximatio"; it first appears tentatively in the 1738 "Doctrine," where the seven lines of Corollary X are increased to nearly fifty lines, while in the 1756 "Doctrine" this corollary alone occupies some four pages or about 160 lines. Indeed the 6¼ pages of the "Approximatio" become 11¼ pages (of more lines) in the 1756 "Doctrine." As De Moivre appropriately observes, he has reserved to himself "the right of enlarging my own thoughts." That enlargement, developing Newton's idea of an omnipresent activating deity, who maintains mean statistical values, formed the foundation of statistical development through Derham, Süssmilch, Niewentyt, Price to Quetelet and Florence Nightingale. These may be mathematically 'minor' points, but they are vital for the history of statistics, and my reference to these additions in the penultimate paragraph of my paper might have shown Prof. Archibald that I was aware of the differences between the original "Approximatio" and the same dealt with in the "Doctrine of Chances." My error lay in not recognising that in the 1738 "Doctrine," the 6¼ pages had grown to a little over 8, to become 11¼ pages eighteen years later.

As to Dr. Todhunter, I have nothing whatever to retract in my judgment. In his Art 335 he misses entirely the epoch-making character of the "Approximatio" as well as its enlargement in the "Doctrine." He does not say: Here is the original of Stirling's Theorem, here is the first appearance of the normal curve, here De Moivre anticipated Laplace as the latter anticipated Gauss. He does not even refer to the manner in which De Moivre expanded the Newtonian theology and directed statistics into the channel down which it flowed for nearly a century. Almost everywhere in his "History" Todhunter seizes a small bit of algebra out of a really important memoir and often speaks of it as a school exercise, whereas the memoir may have exerted by the principles involved a really wide influence on the development of the mathematical theory of statistics, and ultimately on statistical practice also.

Todhunter fails almost entirely to catch the drift of scientific evolution, or to treat that evolution in relation to the current thought of the day, which influences science as much as science influences general thought. The causes which led De Moivre to his "Approximatio" or Bayes to his theorem were more theological and sociological than purely mathematical, and until one recognises that the post-Newtonian English mathematicians were more influenced by Newton's theology than by his mathematics, the history of science in the eighteenth century—in particular that of the scientists who were members of the Royal Society—must remain obscure

Karl Pearson

March 18, 1926.

Muscular Contraction.

In the *Proceedings of the Royal Society*, Ser. B. Vol. 99, No. 694, December 1, 1925, W. E. Garner has published a paper that has interested us very much, because we are studying the possibility of a similar theory of muscular contraction. There is, however, sufficient difference in the mode in which we formulate our theory to make it worth while to describe our hypothesis. Moreover, we have succeeded in several experiments in producing evidence in support of our suppositions.

A first point of importance is, that measurement of the size of the fibrils in skeletal muscle seems to indicate that the total surface is larger than 20,000 sq. cm. We found that the distance of the transversal discs in muscles of rabbits was 1·8μ ($\pm$0·1) and the distance apart of two longitudinal fibrils 0·8μ ($\pm$0·1). From these values it is possible to calculate that the total surface of the fibrils in one gm. of muscle is 5 sq. m. or less and the surface of the transversal discs (both sides) 1·0 sq. m. In close agreement with these numbers is the surface occupied by all the lipoids extracted from 1 gm. of muscle when spread out on a large water surface and measured on the Adam-Langmuir apparatus. Twelve experiments gave results between 6·7 sq. m. and 7·1 sq. m. This agreement already indicates that the lipoids are spread out in a mono-molecular layer on the surface of the fibrils (and perhaps also of some transversal discs). (Cf. our paper on the bi-molecular layer of lipoids on chromocytes, *Journ. of Exp. Medicine*, 1925.)

Now when we make these same measurements in heart muscle of rabbits, we find much smaller distances between the fibrils, which are about half of those indicated in rabbit skeletal muscle. It is also a remarkable fact that the surface occupied by the lipoids from 1 gm. of heart muscle is about twice as large as that occupied by a similar extract of skeletal muscle. We found 16·6 sq. m. to 17·8 sq. m. in heart muscle.

The change of this lipoid film seems to us a very important phenomenon in muscular contraction. We would suggest a hydrogenation of the lecithin-kephalin molecules that form the principal fraction of the lipoid of muscle (only $\pm\frac{1}{10}$ is cholesterol) under the influence of hydrogenation and the formation of hydro-lecithin and hydro-kephalin. The effect would not only be a change in size from 2 to 1, but also a change in rigidity of the surface of the fibrils. A simple calculation shows that by a change of the total surface of an element having the dimensions $0{\cdot}8 \times 0{\cdot}8 \times 1{\cdot}8\mu$, into one of the dimensions $0{\cdot}8\sqrt{2} \times 0{\cdot}8\sqrt{2} \times (1{\cdot}8/2)\mu$, has the effect of decreasing the surface $\sqrt{2}$ times. We are therefore able to explain the shortening of a muscle fibril to half its length by changing 1·4/2 part of the total surface from lecithin into hydro-lecithin. For, as Leathes has shown, the spreading of the molecule of lecithin is 114×10^{-16} sq. cm., whereas hydro-lecithin gives half this value: 56×10^{-16} sq. cm. Lecithin is semi-liquid and hydro-lecithin a solid crystal powder.

Now it is clear that lactic acid cannot produce this change from lecithin into hydro-lecithin. It can be shown, however, that lactic acid, formed in the anærobic phase of the muscular contraction, has another influence. It acts on the protein in much the same way as hydrogen acts on lecithin in the presence of a catalyst.

It is possible to determine the total surface on water occupied by a certain portion of a protein extract from muscle when spread out on a water surface. In a great number of experiments we were able to show that a protein solution from the skeletal muscle of the rabbit always occupies the same surface on water, the nitrogen content of the extracts being equal. Taking 34,000 as the molecular weight of these proteins, we always find a surface of $\pm 1400 \times 10^{-16}$ sq. cm. for each molecule, which enables us to calculate a thickness[1] of $\pm 30 \times 10^{-8}$ cm at zero-pressure (extrapolated).

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[1] This value is independent of the molecular weight.

From this number and from the protein content of the muscle, it is possible to calculate that the total surface of all the protein of 1 gm. of muscle would be ±50 sq. m., assuming that all the protein is in the same condition as the protein on the water surface (a highly improbable supposition). Now lactic acid —like other acids—has a striking influence on the size of the area occupied by this protein solution on a water surface. After adding so much lactic acid that the *p*H changes gradually from 6·4 to 4, we find that the area remains practically constant from 6·4 to 5·4 and changes suddenly between 5·4 and 4·8 into one having much smaller dimensions. At about *p*H4 it is not much larger than 450×10^{-18} sq. m.

There is a close agreement between the small quantity of lactic acid required to bring about this sudden change of the spreading of the protein molecules, and the lactic acid produced in a single contraction as calculated by A. V. Hill (0·031 mg. per gm. muscle). Much depends on the buffer value of the solution used for the experiments. If we take a very feebly buffered solution of $\frac{1}{1000}$ mol. KH_2PO_4, so little as ±1·6 c.c. of a tenth molar solution of lactic acid per litre is capable of producing the effect (0·015 mg. per c.c.).

From our experiments with hæmoglobin (*Proc. Roy. Acad. of Sci., Amsterdam*, Dec. 19, 1925) and with other proteins, we are inclined to consider this change in the size of the protein molecule on a water surface under the influence of differences of the *p*H of the solution as a general property of all proteins. We only add here that further increase of the acidity tends to produce the reverse effect, so much so, that the largest surfaces occupied by protein molecules are two to four times larger than those on neutral water. We get on $\frac{1}{4}$ molar hydrochloric acid a film having a thickness of 6·6 to $7{\cdot}5 \times 10^{-8}$ cm. These are considered by us as layers having the thickness of one amino-acid (Cf. de Nouy, *Journ. Biol. Chemistry*, 64, 1925.)

There exists some evidence indicating that hæmoglobin is orientated at some surface inside a red blood cell in such a way that all the hæmochromogen and iron is placed at the surface. By analogy we suggest that the cystine (or glutathione) part of each protein molecule in muscle is orientated at some external surface, and it is probable that this surface is again the surface of the fibrils, and that the glutathione-lecithin is orientated in opposite places, in order to give the reversible reactions of reduction and oxidation, during muscular contraction and relaxation.

E. GORTER.
F. GRENDEL.

Leyden.

Bigamous Hydrogen—a Protest.

NATURE is always both helpful and challenging and though these be degenerate days, in which the policeman stops duelling, as there is no organised scientific police force, some of us must answer her call and at least constitute ourselves special constables in protection of the liberties of our craft. Scientific son as I am, plus sixty years old, of Frankland, who was the first to enunciate the doctrine of valency, *upon which our entire system of structural chemistry is based*, I have been accustomed always to regard hydrogen as the most single-minded and moral of monogamists. If the story of chemistry, especially that of paraffinic chemistry, mean anything, it is that carbon and hydrogen are mutually satisfied when the carbon atom is married with four hydrogen atoms. The indifference to all external temptation of such unions is most remarkable: whether rightly or wrongly, we have, in consequence, built our entire symbolic edifice upon the assumption that hydrogen is a consistent monad.

I notice that, in the lecture, in honour of Biot, which Prof. Lowry gave recently, in Paris, upon his own work (NATURE, February 20, p. 271), he brought forward certain freak formulæ for tartaric acid, in which hydrogen figures as bigamist. I publicly protested against such aspersion by him of its character, last April, in Brussels: yet the libel is repeated. I may say, he but follows the loose example set by certain Uesanians, especially one E. N. Lewis, a Californian thermodynamiter, who has chosen to disregard the fundamental canons of chemistry—for no obvious reason other than that of indulging in premature speculation upon electrons as the cause of valency: in effect, he has but substituted pairs of dots for the chemist's single bond, thereby deluding himself, apparently, into the belief, that a love-pair of electrons may be hugged by the single hydrogen atom. The way in which the speculation is set out is open to question chemically on almost every page. To quote one case: we are told, that having painted hydrogen as electronegative, as the analogue of fluorine (!), the author had predicted that metallic hydrides would prove to have the character of salts and give hydrogen at the anode. This prediction, we are told, "has been entirely verified in the work of Bardwell (1922), who succeeded in electrolysing a melt containing calcium hydride and obtaining hydrogen at the anode, in amount corresponding to Faraday's Law" No proof has been given, that this hydrogen was not merely displaced by the alkali-metal liberated, during electrolysis, from the fused mixture of alkali-metal chlorides with the hydride used in the experiment. That a writer who belongs to the physical school should be oblivious of such possibility is astounding.

The bigamy of hydrogen is disguised by the blessed word co-ordination—which to-day covers a multitude of wild speculations. Hydrogen, like oxygen, forms co-ordination compounds, says Prof. Lowry. "The real existence of this type of co-ordination can be proved [*sic*] both by crystallographic and by chemical evidence. The X-ray analysis of ice has proved [*sic*] that each atom of hydrogen is surrounded symmetrically by four atoms of hydrogen and that each atom of oxygen is placed symmetrically between two atoms of oxygen."

I heard Sir William Bragg give his paper on ice at the Physical Society and well remember how carefully he pointed out, that the experimental evidence was in no way complete. Do we in the least know the structure of ice? Does position, as determined by X-ray analysis, settle valency? Sodium in salt has six chlorines and chlorine six sodiums surrounding it—are sodium and chlorine to be declared hexads? We are assured that they are not even combined in salt. I would add—we do not believe this, those few of us who are chemists and take some notice of laboratory facts.

As to Prof. Lowry's chemical evidence—

"The simplest chemical evidence for the co-ordination of hydrogen is to be found in potassium hydrofluoride, $KHF_2 \rightleftharpoons \overset{+}{K} + \overset{-}{HF_2}$. A complex anion is here formed by the union of two fluoride-ions and one hydrogen-ion. Since the fluoride-ions are both negatively charged and each ion carries a complete octet of electrons, there can be no direct attraction between them. Since, however, both fluoride-ions have an attraction for the positively charged hydrogen-ion, this may very well act as a link between them as in the formula $:\underset{\cdot\cdot}{\overset{\cdot\cdot}{F}}:H:\underset{\cdot\cdot}{\overset{\cdot\cdot}{F}}:$ or $\overset{-}{F}\overset{+}{H}\overset{-}{F}$, where the two fluorines are linked together by a hydrogen nucleus, in just the same way as the oxygen atoms in ice."

From beginning to end this passage is nothing but stark, unsupported and unsupportable assumption and assertion. As it is "off the rails," such speculation, however, in these days of loose thinking, is regarded as something to be worshipped and imitated. "Dragons that are but clay within and brass without" still secure adoration. As of old, they need to be burst asunder with "lumps of seethed pitch and fat and hair."

Prof. Lowry finds difficulty in "the free rotation of the molecule [of tartaric acid] about the single bond between the two central carbon atoms"—hence his device of connecting by means of hydrogen.[1] I suggest that there is no sufficient evidence that such free rotation is usual, if possible. He also speculates as to the character of the dissymmetry of camphor. On this, may I suggest, that the camphor formula which we are accustomed to use is geometrically impossible. I began my career by doubting Kekulé's formula—at its close, I take leave to question the long fashionable substitute and would even assert that the views now current upon the structure of the compounds of the polymethylene and terpene class are often fundamentally unsound and in need of revision.

Prof. Lowry's early optical work is of such perfection, that it is most unfortunate that he, of all chemists, should now indulge in these obscurantisms. The bump of judgment seems to be lacking in the modern school of chemistry—the judicial sense is nowhere to be found. Seemingly, any wild-cat speculation may be indulged in upon paper. Surely, it were time that we returned to serious work in the laboratory and that some effort were made to inculcate the principles of logic into the minds of university students. The entire system of academic teaching is fast becoming suspect: the product is not what we need in practice: it has no power of reasoning upon observation.

HENRY E. ARMSTRONG.

New Experimental Results concerning the Doublet $K\beta_1$.

IN a paper recently published (*Z. f Phys.* 33, 601, 1925) the present authors came to the conclusion that the new line β' constitutes with the line β_1 the "relativity doublet." In a letter received by the authors, Prof. Sommerfeld points out that, in his opinion, the line β' ought to be considered as a spark line or as a line of unknown origin, since $\Delta\lambda'$ according to our data is equal to 4·3 $X.U.$, whilst according to Allison's $\Delta\lambda$ for M_5 is equal to 0·56 $X.U.$ The value given by Allison may be verified with the aid of the data for the wave-lengths $L\beta_3$ and $L\beta_4$ which are emitted, when the transition of electrons takes place between the levels M_3 or M_4 and the level L_2, while the transition of electrons from the same levels M_3 and M_4 to the level K gives rise to the lines $K\beta_1$ and $K\beta'$. Accordingly we obtain for $\Delta\nu/R$ from the data for the L series for M_5 the value 1·63, and from Allison's data - 1·27.

The agreement is quite satisfactory. However, we cannot act similarly in our case, as the data for the L series for manganese and the neighbouring elements are not known. Nevertheless, Sommerfeld's point of view may be subjected to another test. In accordance with Wentzel's theory the presence of the spark lines in the part of the spectrum close to the line $K\beta_1$ is due to the fact that the atoms of elements from copper downwards, possessing an uncompleted group M, readily pick up an additional electron and retain it on one of the M levels. Consequently the levels in the corresponding atoms ought to be displaced, and therefore a displacement of the lines of the K series must be expected.

What is the actual process by means of which the catching of an additional electron in the uncompleted group takes place? This may be realised in different ways. For example, the electron striking the anticathode may under favourable conditions penetrate inside the atom and be kept there in the group M, or one of the electrons ejected from the level K may also be stopped in the group M. There are undoubtedly other possible cases, when the electrons may be caught in the uncompleted group. Therefore the existence of atoms of two different kinds seems to be probable: the normal atoms and the atoms charged with an additional electron in the uncompleted M group, by means of various processes.

It is obvious that the atoms in which the additional electron has been ejected from the K level possess the greatest probability of the emission of the line $K\beta'$. If this process actually takes place, we are justified in expecting to find in the absorption spectrum the absorption lines of the wave-lengths equal to $K\beta'$, or close to it. The effect of the absorption may be easily estimated. The relative intensities of the lines of the K series are 100, 50, 35, 17·5, and 15 (Siegbahn; Seljakow and Krasnikow). Hence, it may be stated that the probability of the transition of electrons from the M level to the K level will be roughly 8 per cent. of the probability of the ejection of electrons from the K level. Therefore an electron must be ejected from the K level to one of the M levels not less than 8 times in 100, in other cases being expelled outside the atom. From Glocker's formula it may be calculated that a line in the absorption band, after passing through a sheet of iron or manganese 0·02 mm. thick, will be weakened 1000 times more than any line out of the absorption band under the same conditions. Then one can expect that the lines $K\beta_1$ and $K\beta'$ from manganese and iron, after passing through sheets of manganese and iron 0·02 mm. thick, will suffer weakening to a markedly different degree, or at least that a new absorption line will appear close to the line $K\beta'$.

The experiment gives opposite results: namely, the ratio of the intensities of the lines $K\beta_1$ and $K\beta'$ in the absorption spectrum remains actually the same as in the emission spectrum. There is also no trace of any absorption line in the region we are interested in. Moreover, it was of some interest to know if the line $K\beta'$ would appear at the critical voltage or not. For that purpose the constant voltage was supplied by a Siemens machine of 10,000 V. Thus the voltage did not exceed the critical value for manganese by more than 200-300 volts. Experiments have shown that, in the presence of the line $K\beta_1$, the line $K\beta'$ was always present, and vice versa, in the absence of the first line the second was also absent. The ratio of the intensities remained unaltered and equal to that observed at high voltages.

On the strength of these experiments combined we are led to conclude that the level from which the transition of an electron gives rise to the line $K\beta'$, may be considered as a normal, and hence the combination of the lines $K\beta_1$ and $K\beta'$ is a "relativity doublet." Ray, Ray and Siegbahn (*Phil. Mag.* 1, 1924, and *Phys. Ber.*, 1925) have shown that the law $\Delta\lambda = \text{const.}$ does not hold for the "relativity doublets" in the region of elements, where, according to Bohr, the reconstruction of the inner electronic groups takes place. In these regions $\Delta\lambda$ shows a sharp maximum. A similar phenomenon, in an even more striking form, may be expected in the case of $\Delta\lambda$ of the doublet $K\beta_1$, as exactly the same group, which is in a state of reconstruction, gives rise to the lines of the doublet.

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[1] In discussing the anomalous rotatory dispersive power of solution of tartaric acid, in 1913, Dr. E. E. Walker and I suggested alternative formulæ (*R. Soc. Proc.*, 88, 388). We need to know if any change in real acidity take place as the acid changes. Perhaps, as crystal, it may be the dicarboxy-acid and pass over in solution into the monocarboxy-maleic (phthalic) form. Prof. Lowry puts chemical considerations aside.

N. Seljakow.
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January 18.

The Fluorescence of Mercury Vapour.

In the course of the study on the band absorption and fluorescence of mercury vapour I have obtained some results, which partly complete but partly contradict former experiments In the present experiments special care has been taken to maintain the mercury vapour at precisely definite conditions.

Wood (*Proc. Roy. Soc.*, 99, 362, 1921) and Wood and van der Lingen (*Astrophys. Journ*, 54, 149, 1921) have found that the fluorescence of mercury vapour cannot be excited in quiescent vapour, but only in vapour which is being distilled from the liquid metal at a temperature of 150° C. or more. These authors have arrived at this conclusion as the result of experiments made with several exhausted quartz vessels containing mercury. These vessels were heated and illuminated by an aluminium spark. The fluorescence occurred only in the case when the distillation or a stronger evaporation took place, namely, when a part of the vessel was cooled by an air blast or when the temperature of the entire vessel was rising. If the temperature remained constant for a short time or fell, the effect disappeared altogether.

My first experiments upon this subject were made with a quartz Dewar-flask specially designed for absorption measurements. The flask, carefully cleaned and dried by heating, contained between its walls a certain amount of pure liquid mercury It was connected with a constantly working mercury-vapour pump. The vessel was heated in an electric oven and the fluorescence excited by a mercury arc lamp or by condensed sparks with electrodes of aluminium, cadmium and zinc. When the temperature of the entire vessel was kept constant at about 155° C. or higher, green fluorescence limited to the beam of the exciting light was definitely observable. With increasing temperature the fluorescence became stronger. When the temperature fell, the fluorescence got gradually fainter and disappeared only at about 155° C., which is not in agreement with Wood's experiments referred to above. Moreover, by a local cooling of the wall of the vessel by means of an air blast or water, the intensity of fluorescence diminished with diminishing vapour density, instead of rising as reported by Wood.

These experiments were, however, not considered convincing, since in the vessel connected with the pumps a distillation, weak as it might be, could possibly take place. In order to avoid this difficulty, some experiments with sealed vessels were performed. Two quartz tubes provided with quartz plates at the ends were used successively Each tube containing a few drops of mercury was heated in an electric furnace closed by quartz windows; the temperature was measured at three different places by means of thermopiles fastened to the walls of the tube. The fluorescence radiation excited by an aluminium spark was observed visually and photographically. The fluorescence spectrum was taken with a quartz as well as a glass spectrograph The results obtained in these experiments fully confirm previous ones. The intensity of fluorescence remains unchanged if the entire tube is kept at constant temperature, *i.e.* when distillation and stronger evaporation—as by rising temperature—are avoided. No increase of the fluorescent radiation results from local cooling of the vessel.

The total intensity of the visible fluorescence in saturated mercury vapour as well as that of different bands and lines in the visible and ultra-violet part of the spectrum seems to be, for a given exciting light, a function of the temperature only.

In the spectrum of the fluorescence light of mercury vapour excited by an aluminium spark, besides the bands and lines observed by Wood and van der Lingen (*loc. cit*), the line 4358 Å U. was found This line is well seen on the continuous ground of the visible band. It appears at about 200° C. as a very faint line, gets stronger with rising temperature, and reaches the maximum at 230° C.-270° C, slowly declining at still higher temperatures; at 345° C. it is scarcely seen. In connexion with the line 4358 Å.U ($2p_2$-$2s$) the behaviour of the line 2537 Å.U. ($1S$-$2p_2$) in the mercury fluorescence spectrum excited by an aluminium spark may be worth mentioning. The latter appears at about 130° C, its intensity grows with the temperature, reaches a maximum value at about 230° C. and then rapidly decreases and vanishes at about 260° C.

Power (*Phys Rev.*, 26, 761, 1925) and Kapuściński (Nature, 116, 863, 1925) have observed in the fluorescence spectrum of cadmium vapour excited by some sparks, different from those of cadmium, the line $2p_2$-$2s$ analogous to the mercury line 4358 Å U. They have observed also two other lines $2p_1$-$2s$ and $2p_3$-$2s$. No trace of the corresponding mercury lines 5461 Å.U. ($2p_1$-$2s$) and 4047 Å.U. ($2p_3$-$2s$) could be found in these experiments

A detailed account of these experiments will be published elsewhere.

Henryk Niewodniczański.

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March 10.

Alternating Intensities in Band Lines.

Bands in the spectra of neutral and ionised nitrogen show unexplained alternating intensities, and the bands of helium are best interpreted if one assumes that only half the lines are observed, the alternate lines being not merely weak but missing altogether (Mecke, *Zeits. f Phys.* 26, 227, 1925; 31, 709, 1925) A similar effect seems to be present in oxygen, although the interpretation is less certain. All these molecules are symmetrical, composed of two like atoms. I wish to suggest that the alternations may be connected with the well-known difficulty of assigning the proper period in quantising the rotation of a symmetrical system (Ehrenfest and Tolman, *Phys. Rev.* 24, 287, 1924).

If a dumbbell rotates about the perpendicular bisector of its axis, it returns after half a revolution to a state which cannot be told from the initial state; the place of each end of the dumbbell is taken by the other end. If we wished to quantise the rotation, we might think that the right period for integrating pdq was this half rotation. Then, using p_ϕ, the angular momentum, and ϕ, the azimuth, we should have $\int_0^\pi p_\phi d\phi = nh$, $p_\phi = nh/\pi$. That is, the angular momentum of successive allowed states would differ by h/π, twice the normal amount of $h/2\pi$, and we might say that every other level was missing. It seems physically most likely that there would be some continuous kind of transition from this case to the case of a non-symmetrical rotator, where all the states are present, and the only possible way would be to have the missing levels gradually appear with increasing dissymmetry of the rotator, first with very small *a priori* probability, and finally assuming their normal *a priori* probability in a sufficiently assymmetrical rotator. The extreme case of symmetry might actually occur in the helium molecule, the intermediate state in the nitrogen.

Such an explanation demands that anomalous intensities should depend on the properties of the states, not of the transitions. On examination of the data one finds that in every case the lines starting or ending at a given rotational state are either all strong or all weak; there are never some strong and some weak lines from a single state. This holds both for the lines belonging to the various branches of a single band originating from a given state, and for lines of different bands which have the state in common. On the basis of this it is plausible that the effect should come from anomalous *a priori* probabilities of the alternate levels

If the alternating intensities come from symmetrical rotations, some polyatomic molecules containing two or more like atoms might show them. For example, H_2O has the shape of an isosceles triangle, with the O at the apex. If this rotated about the axis passing through the O and bisecting the base perpendicularly, we should have a condition similar to what has been described, so that one rotational degree of freedom should show the effect, not the others. In NH_3, which forms a tetrahedron with the N at an apex and the three hydrogens in an equilateral triangle, a similar rotation would disclose a three-fold symmetry, which might lead to bands with every third line strong. Methane, CH_4, which is presumably a regular tetrahedron of H atoms with the C in the middle, would have a mode of rotation in which it had a two-fold symmetry, and this may explain why in the spectrum of methane two kinds of bands are observed, one with lines spaced about twice as far apart as in the other.

It is a pleasure to acknowledge my indebtedness to Dr. R. S. Mulliken and Prof. E. C. Kemble for very valuable advice and suggestions.

J. C. Slater.

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Harvard University.

The Real Meaning of the New Conception of Time.

The fascinating presidential address of Dr. Jeans to the Royal Astronomical Society, published in Nature for February 27, with its poetical allusions to children chasing a rainbow over the hills, and to what seems the successive extinction of the shires as one gazes at the country from the windows of an express, must have helped many of us to make fast our hold upon the principles of the general theory of relativity. Yet it is doubtful whether the full implications for the doctrine are generally realised—of such a statement, for example, as "The year 1927 has the same sort of existence as the county of Cornwall." The legitimate inference surely amounts to nothing less momentous than this: that everything that has ever existed or happened, or that ever will exist or happen, in the universe, is immanent in physical space-time or 'ether'; and that what to us participators in the drama being enacted on the space-time stage appears to be the *special* differentiation of the present—of *now*—from the past and the future, is merely an illusion due to our experiencing changes in a certain dimension of the four-dimensional continuum, which imparts the impression of travelling along that dimension and hence the idea of flowing time

Let us now imagine ourselves, not as pieces in the drama, as actors on the space-time stage from which we can only obtain a limited view of the picture, but as looking on to the stage from an external point of vantage. By the very terms, apparently, of the doctrine of relativity, we should be witnessing the whole evolutionary drama of the physical universe *coexisting* from 'beginning' to 'end,' beholding our ancestors of a thousand years ago with the earth as it then was in the same picture with our actual selves in 1926 and with our descendants of a thousand years hence with the earth as it will then be. The year 1926 would be differentiated in this synoptic view merely in this: that we should recognise from our non-spatial, non-temporal, point of vantage that what in the physical space-time landscape we are calling the present time—our present life—so far from constituting the fullness of life is but an eclipsed view of it.

I submit that, unless words have broken down under the strain to which expositions of relativity have subjected them and have lost their force and vitality, all this is a necessary deduction, signifying to the universe a realism of the grandest kind. Moreover, if space-time ether is thus the scroll, so to speak, upon which everything is recorded, including our own deeds and misdeeds, do we not find a purely *natural* interpretation of certain widely held tenets in religion? The point is, that if the geometry and the mechanics of the world are one, then every *physical* event must fit into the scheme, including our own physical lives and actions. The question of the *nature* of our higher mental or spiritual faculties, operating through matter, is not involved in these implications, but is obviously raised more insistently than ever.

L. C. W. Bonacina

March 23.

A Planarian Species new to Britain.

Specimens of *Planaria albissima*, Vejd., a Triclad Turbellarian not hitherto known to occur in Britain, have been collected in the environs of Aberystwyth, Wales. My preliminary identification was confirmed by the kindness of Mr. E. Percival, of the University, Leeds. The species was found by Vejdovsky in spring-brooks in Bohemia, and Steinmann refers to it as 'rare'; thus the occurrence in the mid-Cardiganshire area is of especial interest. In this area it is very general in distribution; I have found it in rivers and brooks of all types, and at altitudes ranging from practically sea-level to 1250 feet above. Many of the specimens are sexually mature, and asexual reproduction by transverse fission appears to be common.

Kathleen E. Carpenter.

Department of Zoology,
University College of Wales,
Aberystwyth, March 20.

Dr. Carpenter has kindly allowed us to examine specimens which were undoubtedly mature *Planaria albissima*, Vejd. On comparing these with drawings of immature specimens taken near Leeds in May and October 1922 and March 1923, and Pateley Bridge, we feel convinced that the specimens from Yorkshire belong to this species. So far we have failed to find examples in which the sexual organs are developed

H. Whitehead.
E. Percival.

The University,
Leeds.

The Rugby Wireless Station.

By Dr. W. H. Eccles, F.R.S.

THE Government wireless station at Rugby, now almost completed, is the only one of its class in the British Empire, and is the most powerful wireless station in the world. It was designed by the Wireless Telegraphy Commission and erected by the Wireless Section of the Engineering Department of the Post Office. During design and erection many new problems arose, partly because thermionic valves had not been used on so large a scale before, and partly because extreme efficiency was imperative in order to meet the Government's demand that the station should communicate with every part of the Empire. Many features of the station are novel and of wide interest.

The station occupies a site one and a half miles long and nearly a mile wide, containing about 900 acres, at 340 feet above sea-level. It has twelve masts, each 820 feet high, spread round the edges of the site a quarter of a mile apart. In the middle of the site are the buildings. The machinery hall is 185 feet long × 47 feet wide × 32 feet high, and contains electrical machinery of total power 800 kilowatts, fed from the public supply. A parallel hall measuring 103 feet × 40 feet × 68 feet contains the thermionic triode valves on the ground-level, the condensers on the next level, and the inductances on a still higher level. There are a number of smaller rooms for auxiliary machinery, together with offices, workshops, and testing rooms.

As a rule the steel lattice masts at big wireless stations are earth-connected at their bases and, in consequence, the oscillatory current in and out of the antenna induces oscillatory current up and down the masts. This induced current diminishes the radiation. To ameliorate this defect, insulated masts have been proposed. In fact, insulated masts have been erected in two or three cases, but after being tried have ultimately been connected to earth. The Commissioners thought these failures with insulated masts were due partly to the large electrical capacity between the foot of the mast and the foundation, and partly to bad insulation. They therefore arranged to erect masts on platforms 16 feet above the ground, and made a search for good insulators of small dielectric loss at high frequency. This work was started at Finsbury Technical College by aid of a grant from the Research Department, was continued with more powerful plant at the Admiralty Signal School, Portsmouth, and was concluded at the Post Office arc station at Northholt. As a result, the Commission selected Norwegian granite for the bulky portion of the insulating foot, and porcelain 'cheeses' for the part requiring the greatest electrical strength. As a mast weighs 180 tons, and as the downward component of stress from the stays amounts to more than 100 tons in a gale, these insulators were put through crushing tests as well as high-frequency insulation tests before being accepted for use. The insulation is designed for a quarter of a million volts; the measured voltage during the test of the station has reached 185,000 volts without causing trouble.

The antenna is of novel construction. The traditional 'flat top aerial' consists of a large number of parallel wires running across horizontal triatics which are slung between pairs of symmetrically placed masts; the antenna at Rugby consists merely of one conductor running round nearly the whole circumference of the site by passing from one mast top to the next. The underlying idea is that the electrical capacity to earth of a conductor round the edge of a horizontal elevated area is little less than that of the whole area—that is to say, the interior area adds little to the capacity. A study of the formation of the radiant field enables one to extend the idea to the emission of energy from an antenna. The results achieved by the Rugby station in recent months justify this departure from established practice. Actually, the conductor running round the edge of the site is a composite one consisting of eight phosphor bronze wires arranged as the generators of a cylinder 12 feet in diameter, of which the axis is a steel rope. The wires are supported by the rope on spiders resembling bicycle wheels 12 feet in diameter, which are threaded at equal intervals upon the rope. This skeleton cylinder has an electrical capacity about equal to that of a solid continuous cylinder 7 feet in diameter. It is supported from the masts by halyards each worked by an electric winch near the bottom of the mast. The winches each possess a slipping device set at 10 tons, so that when in a gale or snowstorm the tension in a halyard reaches this figure, the halyard is automatically paid out until the tension is lessened. Rehoisting is done after the storm. Although there is about three miles of this composite conductor hanging in flat festoons each a quarter mile long at a height of 800 feet between the consecutive masts, the slipping device has saved the aerial from breakdown several times during the heavy weather of the past winter.

The method of supplying the antenna with oscillatory current is new and has been developed entirely within the Wireless Research Section of the Post Office. The source of the oscillations is a tuning-fork of frequency 2000 per second, sustained in vibration by a small triode valve such as is used in broadcast receiving apparatus. The sustaining current is distorted by applying a constant negative potential to the grid, and is magnified by passing through two small triodes in cascade with about 150 volts on the anodes. The eight-fold harmonic, that is to say, the oscillation of frequency 16,000 per second, is selected by resonance in a circuit of that natural frequency. The oscillatory current, still very feeble, is now passed through a three-step amplifier using T30 triodes with 1000 volts on the anodes; and the strengthened oscillations then pass to a 600-watt glass triode with 10,000 volts on the anode. The oscillations now go to the grids of three water-cooled metal-glass triodes, from the anodes of which 30 kilowatts of high-frequency power can be drawn. This power is applied to the grids of fifty-four similar water-cooled triodes, also working in parallel, which deliver about 540 kilowatts to the main high-frequency circuit. The anodes of these triodes are supplied with direct current at 10,000 volts by means of motor generators delivering 1000 to 1500 kilowatts at a voltage variable from 10,000 to 18,000 at will. The thermionic current may exceed 100 amperes.

It will be seen that the magnification of the original harmonic in the tuning-fork circuit is enormous; in fact, if we assume that the harmonic is only a few microwatts to start with, the magnification is of the order of magnitude 10^{11} (one hundred thousand million times). Obviously the screening of each circuit from the more powerful one succeeding it in the chain is of the utmost importance and must be carried out thoroughly.

At Rugby the fork has a frequency of 2000 per second and can be slightly adjusted by the inertia effects of small set screws in the prongs. When the temperature in the fork box alters by 1° C. the frequency of the final oscillations changes from 16,000 to 16,001·5, an amount imperceptible in the ordinary receiving apparatus of wireless telegraphy. The advantages of constant frequency are many; but the principal one is that exceedingly selective receiving apparatus can be employed, and all the refinements of accurate note tuning can be utilised, in order to prevent interference by other wireless stations working on nearly the same wave-length.

The design of the high-frequency circuits has presented many problems. These circuits comprise an inductance coil and condensers forming a closed circuit, which is connected on one hand to the anodes of the bank of fifty-four triodes, and on the other hand excites the antenna by means of mutual inductance.

The condensers must withstand a quarter million volts, must pass a thousand amperes at high frequency, and must not cause appreciable loss of energy. Condensers using thoroughly dry and clean oil would probably be best, as oil has a power factor less than one-twentieth of one per cent.; but, in order to save space, mica condensers were adopted, and these have a power factor less than a quarter of one per cent. They weigh more than ten tons. They are carried on a partial flooring about 20 feet above the ground floor on which the triodes stand.

The high-frequency coils in the closed circuit and in the antenna are made of stranded cable containing 6561 separately insulated copper wires of 36 gauge made up by twisting in threes. The coils are of various sizes; the antenna tuning coil, for example, consists of five flat spirals of eight turns each, the outer turn of each spiral being 15 feet 6 inches in diameter. The total weight of the coils is about 6 tons. They are carried on great beams of fir 20 feet above the level of the condensers, and are flanked by flying galleries along which men can pass for inspecting and adjusting the coils. This isolated position is chosen for the coils because the inductive effects of the large high-frequency currents they carry might lead to great energy losses and even to destructive rises of temperature, if any metallic masses were near. The roof trusses, the beams, the supporting framework of the coils, are all of selected wood. The most suitable wood for this purpose, that is to say, the wood with the smallest dielectric loss at high frequencies, is American white wood—a discovery made after long and close investigation in the Post Office laboratories.

The features above described are only a small selection of the numerous novel details with which the station abounds. But the space available permits of no further descriptions. There is just room for a few remarks upon the performance of the station as judged by observers who happened to be listening in at great distances during the tests of the past few months. For example, Newfoundland reported "signals thundering in"; New York said "signals readable through heavy atmospheric and jamming" and "copyable at 75 words per minute"; Cape Town reported "note good and steady"; in the Red Sea "Rugby effectively drowns all interference"; Java reported "key action excellent, frequency very constant"; Dutch East Indies said "Rugby splendidly received, far more distinct than any other European station." The Commander-in-Chief of the China station stated "all ships report note good, clear and steady." Among other Australian stations, Sydney reported "Rugby was only European station readable through atmospherics." These results, it should be noted, have been obtained with less than the full power available. For up to this date only eight of the twelve masts have been utilised on these telegraphic tests, owing to the other four masts being temporarily set aside for the trans-Atlantic telephony trials. The eight mast aerial will take only about 600 amperes without exceeding a voltage of 200,000, and at this rate only about two-thirds of the possible high-frequency power is being drawn from the triodes. But the complete equipment will doubtless be required to ensure communication at all hours of the twenty-four and under severe conditions.

The Stratigraphical Value of Micro-organisms in Petroleum Exploration.

By HENRY B. MILNER.

DURING the last decade of rapid development of technique of petroleum geology, problems of sub-surface stratigraphical correlation have forced themselves to the front, and have engaged the closest attention of geologists operating principally in late Cretaceous and Tertiary oil-fields all over the world. Formerly, and to some extent now, drillers' recognition and classification of rock-chips collected either from bailer or sample box served as a crude guide to underground conditions, though the limited vocabulary and superficial petrological knowledge of the average driller led to some quaint determinations and technically to still more fanciful structural interpretations. 'Gumbo' and 'shell,' for example, cover a multitude of geological shortcomings, while clay, shale, silt, and sand vary in diagnosis largely according to their degree of wetness when they arrive at the surface; anything productive of white powder to the bit is termed 'chalk,' and so on. Such casual nomenclature and equally casual sampling has been part of the long-established code of the oil-well driller, and sufficed until the advent of a more exacting petroleum geology signified the impending and much-to-be-desired change.

The closer study of productive rocks and sub-surface structures concerned with the preservation of petroleum pools has gradually led to the adoption of refined methods of differentiating and correlating strata, and of actual zoning within given formations deep down in the earth's crust; to this end the geologist has been thrown back on his first principles for the requisite desiderata and the aid both of palæontological and petrological data invoked. The frequent divorce between surface and sub-surface structures has to a large extent influenced this trend of field-technique, so that to-day no geologist worthy of the name would dream of interpreting his key-structures on the basis of mere lithological comparison and description, and certainly not in terms of drillers' evidence.

There are four principal methods now employed for studying sub-surface deposits from samples; three are direct, namely, micro-palæontological, microscopical (the examination of rock-cuttings under the microscope), and petrographical (correlation by means of 'heavy' mineral residues extracted from the sediments); the indirect method is that based on comparison of chemical analyses of subterranean (often connate) waters peculiar to certain porous formations. Of these methods, micro-palæontological investigations theoretically take precedence, though in practice this is not always substantiated if the necessary organisms are rare or wanting; the other methods, while capable of considerable precision and accuracy in competent hands, can only be regarded as local and confirmatory, though they are none the less valuable on that account. We dismiss them here, however, in favour of the much-debated problem of the value of micro-organisms as indexes not only of formations, but also of the more restricted developments such as oil-sands.

For obvious reasons, the macro-organic content of oil-well samples is seldom preserved, however prolific the rocks may actually be in molluscan or brachiopodan faunas, etc., though the recent introduction of the core-barrel, and particularly the use of the diamond drill, tend to heighten the possibility of whole shells reaching the surface. For the most part, however, samples from wells are obtained in a comminuted state, so that whatever fragile remains may be originally enclosed in the rocks drilled through, these soon succumb to the drastic action of the cutting bit. Therefore only the initially minute organic bodies stand a chance of escaping disintegration, and consequently their presence in any sample is of paramount stratigraphical importance. The micro-organisms which have received most attention in the course of exploratory work for petroleum are the Foraminifera, Bryozoa, Ostracoda, Radiolaria, Diatomacea, in that order of interest and importance; sponge spicules and echinoderm spines have occasionally proved useful 'indicators.'

It will be at once apparent that, quite apart from a special aptitude for palæontological investigation, the study of these micro-organisms constitutes the work of the specialist; accuracy in diagnosis, dependent on an intimate knowledge of the organisms as regards their morphology and variations, precision in assigning species or groups of species to particular stratigraphical horizons, and vision in detecting the subtler steps in the evolutionary chains involved: all these, among others, are the qualifications for this type of research. Specialisation is to-day the essence of progressive palæontology; the tendency to resort to 'species splitting' is a concrete result of this intensive study, of which there exists no finer example than contemporary work on Ammonoidea, an example fast being emulated by those engaged with micro-organisms, especially the Foraminifera. If, in view of much recent criticism, such technical procedure stands in need of independent defence, the work of certain expert palæontologists engaged on micro-palæontological research for a purely commercial end, coupled with the measure of success already realised, surely provides some vindication.

The organised investigation of foraminiferal assemblages as a basis of zonal stratigraphy, particularly as applied to sub-surface exploration for oil, has derived considerable impetus, if it has not actually evolved, from the intensive work of American palæontologists, more especially those in the employ of oil companies operating in the Gulf Coast region of North America. Considering the comparatively short time taken in developing necessary technique and accumulating the data to work on, the results already achieved are as surprising as they are significant. It is not as though the Foraminifera claimed at the outset of this intensive work a long-established reference library: on the contrary, the literature was scanty compared with that of many other fossil faunas, though the study had at least the example of Chapman and the inspiration of Cushman to guide it. In this connexion Dr. Dumble has written of these palæontologists that they "had very little knowledge to start with and had to build up their own methods" . . . while another expert, Miss H. T. Kniker, now states, "Examination of thousands of well samples has shown which species have limited vertical ranges and therefore which forams can be relied on to make correct stratigraphic correlations. We have learned to do this even on single species, and all of our correlations are made in the main on undescribed forms."

On the other hand, Dr. T. W. Vaughan says that it "appears very doubtful if there is a zonal distinction" of value among the Foraminifera for the discrimination of geological horizons. Further, he says, "In any event, 25 per cent. is about the maximum percentage of the smaller Foraminifera to which any stratigraphic significance may be attached, and it is more probable that the significant percentage is between 3 and 12 . . . 88 to 97 per cent. of the fauna . . . does not possess zonal value. . . . From available evidence, similar faunas of small Foraminifera are indicative rather of similarity in ecologic conditions than of identity in age." This has, on the whole, been the attitude of European oil geologists and certain palæontologists, who have not hesitated to criticise Cushman for his "tendency to split species to a much greater degree than has been done by others," to which 'splitting' he attributes a large part of his success in stratigraphic correlations on the basis of Foraminifera.

Such scepticism as exists regarding the correlative value of Foraminifera finds root in the general impression of the wide space and time distribution of these organisms, and is legitimately maintained so long as we view them from the point of view of world-distribution and their general literature. Until recently, in the absence of local terms of reference such as those emanating from the Texas laboratories, a Cretaceous or Tertiary species of Foraminifer, if still living to-day in the sea, has naturally been regarded as worthless from the zonal or even correlative aspect, and thus has Schuchert sought to explain the critical attitude of Vaughan and others. The whole point of the detailed work, however, is its intensiveness, as is the case with petrographic research under similar conditions, and the fact that local assemblages, rather than precise species, constitute the basis of study; zoning is effected by recognition of slight variations in morphology, ornament, etc., by creating new species or new varieties much as in the case of the ammonites previously cited. The question of percentage of living Foraminifera in any faunule, a point on which Vaughan has laid some stress, is entirely subordinated by the specialists to the question of the actual species present and their manner of combination in any particular faunule. According to Cushman, "the time value of forams . . . is entirely dependent on this splitting (of species), for putting together species which are of short range into one long one would entirely defeat the purpose of close correlation."

Mesozoic and Cainozoic Bryozoa have long been recognised as important indexes of horizon, though in the Gulf Coast oil-field region they are of far less frequent occurrence than the Foraminifera. Schuchert has no doubt whatever regarding their true value for sub-surface correlation, and advocates strongly their use on the basis of Canu and Bassler's classical work. According to Bassler, of the two orders of Bryozoa, namely, Cyclostomata and Cheilostomata, the former has potentially little value in sub-surface work, from the fact that precise diagnosis rests on the preservation of the ovicell, almost an impossibility with oil-well samples. The Cheilostomata, however, can be determined from minute fragments and all characteristics can be ascertained, even though only a few individuals or zoœcia are preserved. They tend to indicate limited time-zones over wide areas, and various structures shown on the zoœcium are significant of depth of water, temperature, nature of ocean bottom and character of marine habitat. Add to this that the calcareous structures are generally highly ornate and variable in that ornament, and the possibility of treating them on the same intensive lines as the Foraminifera is apparent. Canu and Bassler describe 742 forms of North American Early Tertiary Bryozoa in their work, many of which are beautifully illustrated.

Ostracods, as we now realise from the Wealden formations of Great Britain, are potentially valuable as time-indicators, though here again much intensive work has yet to be done before they are fully appreciated. Analysis of well-cuttings from the Gulf Coast region reveals their presence and significance, and Schuchert has directed attention to the highly ornate forms of the valves of these minute crustacea, but the Texan species have yet to be worked out. Ulrich and Bassler have demonstrated their potentiality as guide-fossils to limited portions of certain American palæozoic formations, which research at least forms an adequate basis of future investigation.

In so far as Radiolaria, Diatomacea, sponge spicules and echinid spines are concerned in sub-surface work, at the present time we must regard them in much the same light as petrographers regard sporadically occurring mineral species in oil-well samples: of local and possibly direct differential or confirmatory value. As Schuchert says, "each worker must learn what local dependence can be placed upon these isolated occurrences."

Thus it is clear that while a degree of scepticism regarding the use of micro-organisms in stratigraphical correlation may still be maintained on certain technical grounds, the results so far achieved by the American school are worthy of general attention. It is yet one further example of how much the pure science may owe to one phase of its economic application. Readers are referred to the volumes of the American Association of Petroleum Geologists for 1924 and 1925 for several important papers in connexion with the above, and particularly to Schuchert's excellent summary of the subject in volume 8, 1924, pp. 539-553; these volumes are available for reference in the Science Library at South Kensington.

Sterility and Rejuvenation.

It has been known for a long time that the sexual activity and characteristics of the individual depend on the presence of the sexual glands in an actively functioning condition. Their removal or atrophy as in old age leads to loss of sexual vigour together with changes in the secondary sex characters which may result in the development of a neutral individual, or even in the assumption of certain of the characteristics of the opposite sex, according to the species studied.

Various methods have been used for supplementing a deficiency in the individual's own secretions, such as grafting glands from another member of the same or an allied species, the injection of extracts of the glands, and in males, the ligature of the duct which conveys the sperm from the testes to the urethra: the latter operation (vasoligation) has been performed on the assumptions that the secretions on which the secondary sex characters depend arise from the interstitial cells of the sex glands, and that ligature of the duct, by causing atrophy of the sperm-producing cells, will allow the interstitial cells to hypertrophy, owing to the increased space and nutriment provided. The return of the secondary sexual characteristics does not imply a return of fertility, since, for the latter, the sex glands themselves must be actively functioning *in situ*: that is, atrophied or diseased glands must be reactivated. Grafting alone, therefore, will not restore fertility, except, perhaps, in the case of the female, unless the animal's own sex glands are also reactivated or rejuvenated by means of the secretions from the graft.

Sterility in the female can be caused not only by atrophy (or removal) of the ovaries, but also by persistence of the corpora lutea. During pregnancy these bodies persist and prevent ovulation, and occasionally this occurs apart from pregnancy as a pathological phenomenon and produces sterility, fertility being restored by their removal. It is of interest, in connexion with recent work on the isolation of an ovarian hormone, that W. P. Kennedy (*Quart. Journ. Physiol.*, 1925, vol. 15, p. 103) has found that cold saline extracts of fresh frozen or dried corpora lutea, intravenously injected, prevent ovulation in rabbits: the effect persists for several months after a number of injections. Continued injections cause degenerative changes, not only in the ovaries, where the number of Graafian follicles is reduced, these changes being probably specific, in part at any rate, but also in the liver and adrenal glands, where the effect may be due to the injection of toxic foreign proteins, or alternatively to changes in the carbohydrate metabolism produced by the degeneration of the ovaries. Since extracts of ovarian tissue are being used for the production of the opposite effect, namely, the return of fertility and the secondary sexual characteristics, it is obvious that care should be taken to use only glands in which there are no corpora lutea, or from which these bodies have been removed, for the preparation of such extracts.

The main interest of some recent work by Steinach and his collaborators on the ovarian hormone appears to lie in the true reactivation or rejuvenation of the ovaries of senile animals (E. Steinach, H. Heinlein, and B. P. Wiesner, *Akad. d. Wissensch.*, Wien, 1925, No. 19, p. 189). These investigators have injected extracts of ovary and placenta into animals castrated both before and after puberty, and into senile specimens, using the vaginal smear method to follow the return or not of the œstrual cycle. Extracts from either source favour the development of the secondary sexual characteristics, but only those from the ovary arouse the sexual cycle. In all cases the normal condition of the animal is restored. The effects observed are produced by only a few injections in young animals, and occur within a few days in both rats and guinea-pigs. The fertility of stock female rats ceases when they are about eighteen months old, and the sexual cycle vanishes a few months later. Injections now restore their vigour and produce a reappearance of the œstrual cycle, the latter continuing regularly after the injections have been discontinued: in other words, the ovaries are reactivated. The next step should be the application of a purified ovarian extract in human therapeutics.

Most of the work on rejuvenation has been performed on mammals. Crew has turned his attention to birds. He has found (F. A. E. Crew, *Proc. Roy. Soc. Edin.*, 1925, vol. 45, p. 249) that unilateral vasoligation in senile cocks is not accompanied by any rejuvenating effect. The only change observed microscopically in the testes was continuation of the degenerative processes seen to be occurring at the time of the operation in a preparation of a portion of the testis on the side of the ligature removed for histological study. No change was observed in their plumage. On the other hand, this author has been successful in obtaining rejuvenation in birds of both sexes by the administration of dried thyroid (*ibid.* p. 252). The doses given corresponded to 0·2-0·8 mgm. iodine daily. The first effect noted was moulting by all birds, and this was followed by an increased egg production by the females, the eggs being fertilised by the males; none of the former, however, became broody. The plumage of cock-feathered cocks became henny, but that of the hens and of hen-feathered cocks remained almost unchanged. The author considers that these results can be explained on the assumption that the sexual glands exert their influence on the plumage, not directly, but by means of an action upon the thyroid. Thus there are two classes of fowls: those whose thyroid responds to a certain low degree of stimulation from the testes with the production of cock-feathering, and to a higher degree of stimulation from the ovaries with the production of hen-feathering; and those whose thyroid responds to the greater degree to testicular stimulation, the cocks thus being hen-feathered. The difference between the thyroids of the two classes is a genetic one. The administration of thyroid can only produce a marked effect on those birds the thyroid gland of which is not normally fully stimulated, that is, cocks with cock-feathering.

Obituary.

PROF. K. LHOTÁK.

ON January 27 there died in Prague, at the relatively early age of forty-nine years, Dr. Kamil Lhoták, professor of pharmacology and pharmacognosy and director of the institute for the said sciences in the Charles' (Bohemian) University. Prof. Lhoták published many scientific investigations in physiology, in which he had a sound training, in pharmacology and pharmacognosy, but the most prominent are his researches on the active substances of digitalis (digitalin, digitoxin). Lhoták also published the first Bohemian treatise on pharmacognosy (1908); but especially noteworthy is his voluminous "Pharmacology" (1924), including also the theory and art of prescribing.

As a teacher Prof. Lhoták turned his attention to the practical work of students in his laboratory, based on his experience in England. But one of his greatest merits, from the international point of view, is that he gave an impulse to the reprinting of the scientific papers of the Bohemian genius Ian Purkyně (Purkinje), who founded the first physiological research laboratory in Germany, so that his researches, scattered in less accessible journals, could become accessible to the scientific world. They are published by the Bohemian Society of Medicine, together with two volumes of the very interesting correspondence of a many-sided scientist. Prof. Lhoták was not only of a real, deep scientific nature, but also a great connoisseur of painting, music, and the world's literature. He was a member of the Bohemian Royal Society of Science, the Bohemian Academy of Science and Art, the Ministerial Institute for the Examination of Medicinal Matters, and of the State Hygienic Council, etc.

BOHUSLAV BRAUNER.

WE regret to announce the following deaths:

William J. Green, a pioneer in horticultural investigations and for many years horticulturalist at the Ohio Experiment Station, aged seventy-six years.

A. Witz, formerly professor of physics in the Catholic University of Lille, corresponding member of the Paris Academy of Sciences, who was known for his work on thermodynamics and on internal combustion engines, on January 25, aged seventy-seven years.

News and Views.

The Prime Minister is one of the all too rare administrators who fully appreciate the importance of the part played by science in modern life, and his sympathies in this connexion found expression in the address with which he opened the Optical Convention at South Kensington on April 12. In pointing out the vital rôle of optical science in the everyday life of peace no less than of war, he gave as a homely but arresting illustration the fact that even a glass of beer depends for its satisfactory manufacture on the use of at least three optical instruments—the microscope, the polarimeter, and the refractometer. He added that in the last century British optical work was predominant in the world's industry, but during its closing years the industry was nearly overwhelmed by foreign competition, especially on the part of Germany. In that country optical manufacturers at that time enjoyed three great advantages: (1) a stronger tendency amongst German than among British industrialists to invoke the aid of scientific research; (2) the demand for optical goods created by the existence of a large standing army; and (3) a protective tariff. At the end of the War, which demonstrated the danger of allowing this key industry to atrophy, the Government of the day decided that its fate must no longer be left to chance, and introduced the two remedies of 'safe-guarding' and a money grant allotted through the Department of Scientific and Industrial Research. Since the War, several new difficulties have had to be faced by the optical industry—a general depression of trade, large surplus stocks of optical material, and the abnormal rates of exchange which made foreign competition acute. In the Prime Minister's view, the Exhibition indicated that in spite of these difficulties the quality of British optical manufactures has again been raised to the highest level of achievement.

Among the varied topics touched upon by the Astronomer Royal in his presidential address to the Optical Convention, delivered on April 12, not the least interesting was the part which British optical designers and manufacturers have played in providing the instruments with which outstanding discoveries have been made in the history of astronomy. Thus the fact that cross-wires could be inserted in the Kepler telescope was first noted by Gascoigne, the possibility of making achromatic combinations of crown and flint glass was discovered by Chester Moore, and re-discovered and published by Dollond, and for a time the manufacture of these was an English monopoly; but in the earlier part of the nineteenth century the industry was crushed by an exorbitant tax on flint glass. In due course this was removed, however, and in the second half of the century British opticians played their part in the provision of objectives of increasing size. A 40-inch refracting telescope is now being constructed in England for Russia. As regards reflecting telescopes, the art of grinding and polishing mirrors was due to Newton, and the parabolic mirror to Hadley. The great development of the reflecting telescope in the second half of the eighteenth century was the work of Sir William Herschel The silvered mirror was a German invention, but was first constructed on a large scale by Dr. Common and Sir Howard Grubb. Good work by British firms was also described in connexion with astronomical photography: for example, an English amateur, Franklin Adams, with a lens made by H. D. Taylor, has photographed the whole sky in 206 exposures. As regards instruments for stellar spectrography, it is of interest to learn that the échelon spectroscope is made only by a British firm.

The breakdown in the negotiations between Mr. John D. Rockefeller and the Egyptian Government over the terms of the proposed gift by the former of a sum of ten million dollars for the construction and maintenance of a new archæological museum and institute at Cairo does not come altogether as a surprise. For some time past the Egyptian public and its representatives have tended to become increasingly assertive of their prerogatives in relation to foreigners engaged in archæological research within their jurisdiction. The official action which interrupted the excavation of the tomb of Tut-ank-Amen, merely gave effect to a widespread and growing feeling among the Egyptians which was brought to a head by methods of securing publicity which many archæologists and others felt to be ill-judged. Undoubtedly among the extremists some would have wished to see Egyptian archæology for the Egyptians as the ruling principle.

In the present case it has been stated that difficulty has arisen over the composition of the committee in whom control of the museum and institute is to be vested for a period of thirty years. While Mr. Rockefeller has explained that this provision is to allow time for a generation of trained Egyptians to grow up who would be fully qualified to take over the custody of the national treasures, the Egyptian Government objects to management by a committee on which two Englishmen, two Frenchmen, and two Americans would sit with two Egyptians only, even though one of these should be the chairman of the committee. Apart from the desire of every archæologist that the advantage to scientific research which must follow from Mr Rockefeller's munificent gift should not be endangered, the importance of Egypt in the history of civilisation gives it a position which is unique and of universal moment. Its records and cultures justly demand the highest skill in investigation, in interpretation, and in preservation To take measures to secure such skill is a duty incumbent on those in authority, which transcends the bounds of nationality.

The airship *Norge* arrived at Pulham on April 11 from Rome, en route for Oslo, where a mooring mast is available, and Spitsbergen, where a mast and partial shelter are being prepared. From Spitsbergen an attempt will be made to transnavigate the north polar regions. The *Norge* was built to the designs of Col. Nobile, in the Italian State Airship Factory at Rome. It is a semi-rigid airship of displacement 20 tonnes, length 106 m., height 26 m., width 9 5 m., power 3 × 190 kw., maximum speed 100 km. per hour. The direct distance from Rome to Pulham is about 1250 km., but the actual course through the Valley of the Garonne, between the Pyrenees and the extensive highlands of Southern France was about 2250. Thanks to favourable meteorological information, the airship did not re-fuel at Rochefort on the west coast of France, but continued the flight to Pulham, covering the 2250 km. without stop in 30 hours, giving an average speed of 75 km. per hour, a very satisfactory performance. The co-latitudes of the most northerly points of Spitsbergen and Alaska are about 10° and 20°, and the polar distances are therefore about 1000 km. and 2000 km. respectively. The transnavigation of 3000 km. of polar wastes without the possibility of intermediate landing and without meteorological information seems a bold undertaking; but it is not in the nature of pioneers to count risks in relation to the results obtainable, and it may be hoped that a combination of favourable circumstances will bring the maximum possible success to these adventurers in the most modern style.

ON April 8 Mr. S. Mavor read a valuable paper to the Institution of Electrical Engineers on the applications of machinery at the coal face He pointed out that, in mining, labour accounts for 75 per cent. of the total costs of production. Many palliatives of the existing situation have been suggested, but, apart from increasing the number of working hours, the only way to effect a substantial increase of the output per man and a consequent reduction of costs is the systematic application of labour-saving machinery. In England the proportion of machine-cut coal to the total output is 14 per cent., but in Scotland the proportion is 47 per cent. The difference is due partly to economic pressure compelling a reduction in the costs of production, but mainly to the fact that electricity can be applied safely at the coal face in most of the Scottish mines. In Scotland more than 93 per cent. of the coal cutters in use are electric, the remainder being compressed air machines

A VERY important factor in the rapid extension of machine mining in the United States is that the comparative freedom from gas in the mines renders electricity permissible In Scotland, however, the rate of increase during recent years in the proportion of machine-mined coal has been even greater than in the United States. Mr Mavor advocates intensive mining on the unit system. The methods must be standardised and a daily cycle of operations established, so that the work becomes comparable to repetitive processes in workshops The principles which have so greatly increased the productivity of labour in other industries should be applied to mining organisation and operations. The output per underground worker is too low, therefore too many men are in the industry, and hence wages are low and costs are high. By mechanical and electrical aids to production the output per man can be increased, wages and the status of the miner can be raised, and the cost and price of coal can be reduced.

THE intimation that Mr. Alan A. Campbell Swinton is retiring from the electrical and general consulting engineering practice that he has carried on for the past thirty-seven years at 66 Victoria Street, Westminster, will not come as a surprise to those who are acquainted with his activities in other directions. Last year his failing health caused grave anxiety to his friends, and they will be glad to know that it is now restored sufficiently to enable him to continue his special consulting work and his electrical and engineering directorships. His address, as formerly, will be 40 Chester Square, S.W.1. There are few men who have maintained touch for so long and so intimately with so many learned societies, technical institutions, social clubs, and commercial administrations. It is of interest to recall that Mr. Swinton was one of the earliest workers with X-rays; and we believe that the X-ray photograph of a human hand, published in NATURE of January 23, 1895, with an article by Mr. Swinton and a translation of Prof. Rontgen's paper "On a New Kind of Rays," was the first radiograph reproduced in Great Britain. The lecture which Mr. Swinton gave at the Royal Society of Arts a few months ago upon persons of distinction in the world of science and engineering, will always be remembered as a valuable and amusing contribution to the history of the scientific men of his time His own part in the advance of electrical science and electrical industry, as a liaison officer between scientific, engineering, and commercial enterprises, has been of considerable value, and good wishes from all these centres of progress will go with him in the comparatively restricted activities which he now contemplates.

THE problem of stage lighting, discussed at the meeting of the Illuminating Engineering Society on March 29, is one in which artistic perceptions and knowledge of scientific principles need to be carefully blended. Mr. H. Lester Groom, in an introductory paper, reviewed recent progress in the design of stage-lighting apparatus, referring particularly to the 'cyclorama' as one of the most important developments during recent years. By its aid the stage is provided with an artificial horizon, and clouds, storms and atmospheric phenomena can be imitated with a fidelity unrealisable in the past. It was mentioned that, on the Continent, cinema theatres are now beginning to introduce such apparatus as an auxiliary to the showing of films, and it forms a valuable aid, provided the dimensions of the stage enable a proper perspective to be obtained. The consumption of energy for the complete apparatus ranges from about 20 to 100 kw. according to the size of the theatre. Other interesting applications of scientific principles include the use of changing coloured light to bring about apparent transformations in scenery, the applications of ultra-violet light impinging on dresses of dancers impregnated with fluorescent solutions, and the possibility of projecting luminous stage scenery instead of using painted canvas. Recently devised apparatus enables the colours to be blended and graduated at will, and any design gradually built up to suit the scenic artist; in addition, the method has the advantage that the contrasts are more vivid—in the same manner as occurs when a lantern slide is substituted for a photographic print. The discussion raised a number of interesting points, such as the desirability of promoting highly diffused illumination and 'soft' shadows, and the difference in the sharpness of definition of objects illuminated respectively by red and blue light.

In view of criticisms levelled against the proposed expenditure of the Boxer indemnity on Chinese education, Mr. Harold Balme's account of educational progress in China under the Republic, in the *Nineteenth Century and After* for April, is opportune. Under the old regime the enthusiasm for learning which was characteristic of the Chinese, or at least such of them as had the leisure for its pursuit, was accompanied by a supreme contempt for the knowledge of the foreigner. Owing to several factors, and particularly to the influence of missionary schools and colleges and of such Chinese as have been trained abroad, this spirit has now disappeared. The old private school with its purely literary training was abolished in 1902. Its place has been taken by 200,000 Government and private schools of all grades, offering modern courses to some seven million scholars of both sexes, and staffed with teachers mostly trained along modern lines. Since 1912, when the new Republican Government reformed the educational system, education has gone forward by leaps and bounds. The difficulty of securing trained teachers has been one of the gravest of a number of causes of difficulty; but this is now being met by the output from the training colleges, of which Mr. Balme speaks highly from personal knowledge. Associations for the reform of education have been formed throughout the country, of which the most important is the National Association for the Advancement of Education. It is significant that these associations have welcomed and invited expert advice from outside China—a fact which augurs well for any system of co-operation between West and East on a permanent basis which it may be possible to set up in the future.

What is described as the greatest live game collecting expedition ever attempted is being sent out by the Smithsonian Institution, in co-operation with Mr. Walter P. Chrysler, the motor car manufacturer, to British East Africa, for the primary purpose of obtaining living examples of African big game and other animals for exhibition in the National Zoological Park at Washington. The expedition will be under the leadership of Dr. William M. Mann, the Superintendent of the National Zoological Park; and other members of the party include Mr. Arthur Loveridge, of the Museum of Comparative Zoology at Harvard, who, as a former game warden in Tanganyika Territory for eight years, possesses a peculiarly intimate knowledge of the country; Mr. S. Haweis, and Mr. Frank Lowe, one of the keepers at the Washington Zoo, as well as artists, photographers, and a kinematograph operator. Among the animals to be sought for are giraffe, black rhinoceros, sable antelope, topi, hartebeest, zebra, guereza monkey, Syke's monkey, lion, eland, and other antelopes and gazelles. Birds and reptiles will also be collected. Opportunity will be taken to make as extensive collections as possible, for scientific purposes, of the general fauna of the country, and valuable results from this point of view may be expected. The expedition will land at Dar-es-Salaam and proceed inland to Tanganyika Territory, and it is expected that at least five or six months will be spent in the field. Memories of the results obtained by the Roosevelt Expedition to Africa in 1909, sent out also under the auspices of the Smithsonian Institution, raise expectations of equally successful results from the Smithsonian-Chrysler Expedition.

In February last it was decided that an address should be presented to Sir Howard Grubb in recognition of his skill and long-continued labours in the production of large objectives for astronomical instruments. Many of these are now famous: they include the 28-in. at the Royal Observatory, Greenwich, the 27-in. at Vienna, the 26·5-in. at the Union Observatory, Johannesburg, the 26-in. at Greenwich, the 24-in. at Cape of Good Hope and also at Oxford, and eight (of the eighteen required) 13-in. objectives for the Astrographic Catalogue and Chart, besides the reflectors—the 40-in. at Simeis, the 24-in. at Edinburgh, and the 24-in. at Daramona. Accordingly an address was drawn up congratulating Sir Howard Grubb on the approach of his eighty-second birthday, in which the signatories recalled "with admiration his devoted application of his resourcefulness and ingenuity to the development of the instrumental equipment of astronomers through more than sixty years." Especial reference was made to the service which Sir Howard Grubb's firm has rendered to science "in the provision of suitable object glasses, and of the refined clockwork needed for the accurate movement of the telescopes," in order to undertake the photographic survey of the heavens. The address was signed by the Astronomer-Royal and the leading representatives of astronomy and astrophysics in Great Britain.

The council of the Royal Anthropological Institute has awarded the Huxley Memorial Medal to Dr. Aleš Hrdlička of the Smithsonian Institution, Washington, and has invited him to deliver the Huxley Memorial Lecture of the Institute for 1927. This invitation Dr. Hrdlička has now accepted. Of the wisdom of the award there can be no two opinions. Dr. Hrdlička has a world-wide reputation as one of the foremost physical anthropologists of the day, and is one of the outstanding men of science in America. His researches on the origin of the American Indian and on the antiquity of man in America are mainly responsible for the present position of our knowledge relating to these important problems, and it is due to his critical and careful examination of the evidence bearing upon the age of the ancient human remains found in America that the extravagant claims for high antiquity which have been put forward from time to time have been demolished. During last year Dr. Hrdlička visited the principal sites in India, Java, Australia, and South Africa on which remains of early man have been discovered, and gave an account of the results of his tour to the Royal Anthropological Institute while passing through England on his return to the United States.

MR. F. W. LANCHESTER has been awarded the gold medal of the Royal Aeronautical Society in recognition of his pioneer work in aviation, and has also been elected an honorary member of the Society.

PROF. CHARLES FABRY, professor of physics at the Sorbonne, Paris, will deliver the eleventh Guthrie Lecture of the Physical Society of London on April 23. The title of the lecture will be "The Absorption of Radiation by the Upper Atmosphere"

SIR JOHN ROSE BRADFORD, formerly professor of medicine at University College, London, has been elected president of the Royal College of Physicians, in succession to Sir Humphry Rolleston, who retires after four years of office.

THE sixteenth annual May Lecture of the Institute of Metals will be delivered on May 19 at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S.W.1, by Prof. H. C. H Carpenter, professor of metallurgy at the Imperial College of Science and Technology, South Kensington, who will take as his subject, "Single Metallic Crystals and their Properties."

AMONG the changes in place-names announced in recent years by the Soviet Government we notice, in the *Weekly News Bulletin*, No. 34, of the U.S.S.R. Society of Cultural Relations with Foreign Countries, that Nicholas Land, which was discovered in 1913 to the north of Cape Chelyuskin, in future is to be known as Northern Land and the adjoining Tsarevich Alexis Island is to be Little Taimir.

THE Council of the Iron and Steel Institute has awarded the Bessemer Gold Medal for 1926 of the Institute to Sir Hugh Bell, Bart. The medal, the award of which is made in recognition of outstanding services in the advancement of the art of the manufacture of iron and steel, will be presented to Sir Hugh Bell at the annual meeting of the Institute on May 6, by the incoming president, Sir W. Peter Rylands.

IT is stated in *Science* that the John Fritz Medal Board of Award, representing the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, has presented the John Fritz gold medal to Edward Dean Adams, "engineer, financier, scientist, whose vision, courage and industry made possible at Niagara Falls the birth of hydro-electric power."

THE annual meeting of the British Science Guild will be held at the Mansion House, London, E.C.4, on April 29, at 4.30 P.M., under the presidency of Lord Askwith. Addresses will be delivered by Sir Richard Redmayne on the future of the coal mining industry; by Dr. E. F. Armstrong, managing director of the British Dyestuffs Corporation, Ltd., on dyestuffs; and by Capt. P. P. Eckersley, chief engineer of the British Broadcasting Company, on broadcasting and the electrical industry in Great Britain.

THE Academy of Natural Sciences of Philadelphia announces that the 1926 Hayden Memorial Geological Award will be made to Dr. William Berryman Scott, professor of geology at Princeton University, in recognition of his "many researches and publications in the field of vertebrate paleontology." The award, which consists of a gold medal, is made once in three years, and was founded as a recognition of pre-eminent work by "publication, exploration, discovery, or research in the sciences of geology and paleontology."

WE have received from the British Museum (Natural History), South Kensington, London, S.W.7, some further series of picture post-cards which are admirably executed by the three-colour process. Set E. 39 portrays *Papilio dardanus* and its four remarkable forms of the female butterfly: E. 40 illustrates some exotic moths, E. 41 exotic beetles, and E. 39 some of the more interesting and striking Hymenoptera. Each of these sets comprises five cards and is priced at 1*s*. The cards are of very definite educational value, being prepared under the supervision of specialists in the subjects dealt with, who are also responsible for the explanatory letterpress. A great variety of other subjects are described and illustrated in the same manner, and the cards are obtainable from the Museum or from London booksellers.

HIS Majesty the King has approved the following awards of the Royal Geographical Society:—*Founder's Medal*: to Lieut.-Col. E. F. Norton for his distinguished leadership of the Mount Everest Expedition 1924 and his ascent to 28,100 feet, *Patron's Medal*: to Sir Edgeworth David for his work on the Funafuti atoll, and with Sir Ernest Shackleton's Antarctic Expedition of 1907-9, as leader of the first ascent of Mount Erebus and of the party which first visited the South Magnetic Pole. The Council has made the following awards:—*Victoria Medal*: to Dr. John Ball for his desert surveys and memoirs on the geography of Egypt; *Murchison Grant*: to Mr. Frank Debenham for his contributions to the scientific exploration of the Antarctic; *Back Grant*: to Afraz Gul for his surveys in Central Asia and Hunza, *Cuthbert Peek Grant*: to Major Kenneth Mason to assist his further exploration of the Himalaya; *Gill Memorial*: to Dr H. Gordon Thompson for his journey on the Tibetan and Mongolian borders of China with Brig.-General George Pereira.

THE fifth report of the Executive Committee of the Universities' Library for Central Europe, covering the period April 1924 to March 1925, shows that there is a demand in every country in Europe for English books and a desire for information as to English culture and ideals. The Committee has striven with some success to satisfy the calls which have been made, but it is evident that it is hampered to some extent by want of funds. The most valuable service performed by this Committee appears to be in filling gaps in serials occasioned by the breakdown of exchanges during the War period and the satisfaction of definitely ascertained wants—but a certain amount of forwarding and reciprocal exchange work was also undertaken. We read, for example, of 400 volumes of German classics being forwarded to Berlin. During the year under review gifts of books and periodicals valued at 150*l.* were received by the Committee and sent abroad. The work of this Committee deserves increased support.

A useful list of 138 atlases, maps, and books of geographical interest has just reached us from Mr. F. Edwards, 83A High Street, Marylebone, W.1. Its number is 486, and it supplements Catalogue 475—"Old Time Cartography." It can be obtained free upon application to the publisher.

Applications are invited for the following appointments, on or before the dates mentioned:—Two laboratory assistants in the biochemical department of the Low Temperature Research Station, Cambridge—The Superintendent of the Station, Downing Street, Cambridge (April 24). An assistant bacteriologist at Queen Mary's Hospital for Children, Carshalton, for research work on acute rheumatism in children—The Clerk, Metropolitan Asylums Board, Victoria Embankment, E.C.4 (April 26). A principal of the South Staffordshire Mining Schools—The Director of Education, County Education Offices, Stafford (April 27). An assistant inspector under the Ministry of Agriculture and Fisheries, in connexion with agricultural and horticultural education and research—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (May 3). A lecturer in charge of the Economics and Commerce Department of University College, Southampton, and an assistant lecturer in geography in the same institution—The Registrar (May 3). A probationer naturalist and a technical assistant under the Fishery Board for Scotland—The Secretary, Fishery Board for Scotland, 101 George Street, Edinburgh (May 9). A male assistant superintendent of traffic (Class II.) in the London Telephone Service, and a male assistant traffic superintendent in the Provinces, G.P.O.—The Secretary, Civil Service Commission, Burlington Gardens, W.1 (June 2) A director of the Amani Institute, Tanganyika Territory—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1 (August 1). Two temporary research assistants under the Foot-and-Mouth Disease Research Committee—The Secretary, Foot-and-Mouth Disease Research Committee, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W 1. A director of research for the Linen Industry Research Association—The Secretary, Research Institute, Lambeg, Belfast.

Our Astronomical Column.

Ensor's Comet.—Mr. S. Seliwanow, of the Observatory of the Russian Society Mirovédénié, Leningrad, writes to say that the Society organised an ascent in a captive balloon on the night of February 22-23 in which he took part. He passed low clouds at a height of 350 metres; above them the air was clear. Using a powerful binocular, the comet was located after a twenty minutes' search south-west of ε Equulei It appeared as a dim indistinct spot 8′ to 10′ in diameter, of about the fifth magnitude. The time was $3^{h}\ 22^{m}$ U.T., the height 700 metres A faint tail, 20′ long, was suspected. A later ascent by G. A. Langé and B. W. Okunev confirmed these results.

Search was made with a 175 mm. refractor on March 6 and 7 without result.

Dr. W. H Steavenson notes that these results, combined with his own, appear to fix the collapse of the comet's light as having occurred between February 23 and 28.

A slide from the Bergedorf photograph of March 16 was shown at the meeting of the Royal Astronomical Society on April 9. It showed a tail 30′ in length, forking into two branches about 20′ from its eastern extremity. The tail made an angle of 80° with the radius vector.

Brilliant Solar Outburst.—At the meeting of the Royal Astronomical Society on April 9, Mr. Evershed showed some spectroheliograms of the sun taken by Dr. Royds at Kodaikanal on Feb. 22, which indicated that an extremely brilliant chromospheric outburst occurred over a sunspot during the course of the observations It was photographed both in hydrogen and calcium light. Some similar outbursts in the past were referred to, including that observed by Hodgson and Carrington in 1859, another observed by Young in 1872, and one observed by Mr. Evershed in Kashmer. Mr. Evershed suggested that the outburst resembled on a small scale those that occurred in novæ. There was the same reversal of lines, and the same indication of rapid radial motion On some of the occasions quoted, magnetic fluctuations have been observed simultaneously with the outburst; he suggested that the magnetic traces should be examined on this occasion. Mr. Newton noted that there was a large magnetic disturbance on February 23, and promised to examine the record of the preceding day.

Measures of the Sun's Diameter.—The facts that the curve of sunspot activity bears some resemblance to the Cepheid light curve, and that a widely held explanation of the variability of the latter stars is that their diameters pulsate, render it quite a pertinent inquiry whether any similar pulsation can be detected in the sun's diameter. G. Armellini, in *Astr. Nach.*, No. 5419, describes a research of this kind made at the Campidoglio Observatory, Rome, from 1877 to 1900, some six hundred measures being made each year by three different observers. The method of projection on a white screen was employed. The mean horizontal semidiameter of the sun for the whole series is 961″·18, agreeing with that used for the bright limb in the "Nautical Almanac" (but not with that of Auwers, corrected for irradiation, which is 959″·63). The measures when plotted by annual means lie on a sinuous curve with maxima in 1878 (961″ 46) and 1891 (961″·76), minima in 1886 (961″·00), and 1897 (960″·70). The fluctuations are large enough to suggest a real change, but the period dealt with is too short to assert with confidence that it is connected with the sunspot variation. Results for the years following 1900 are promised shortly.

Research Items.

The Stone Age of Ceylon.—An important study of the stone implements which have been found in Ceylon, and of the evidence for their antiquity, by Dr. Fritz Sarasin, appears in Nos. 1-2 of vol. 36 of *L'Anthropologie*. As in the case of other finds in subtropical or tropical Asia, owing to the absence of such indications of age as is afforded by glaciation in western Europe, or the presence of extinct fauna, it is difficult to correlate the implements with the recognised phases of the Stone Age in Europe. Of the views that have been put forward by various writers, that which assigns these implements to the Neolithic period is scarcely likely to be correct. It is precluded by the absence of polished implements, of pottery, and above all of the typical neolithic axe, both from the implementiferous strata in the caves which have been explored, and from the similar surface finds. The author's view is that they must be assigned to the Upper Palæolithic. This is confirmed by the results of a recent visit to Ceylon in 1924 to test the conclusions put forward by Mr. Wayland that he had discovered implements belonging to the Lower Palæolithic. The resemblance of certain types to Early Palæolithic implements is accounted for in part by the material employed, which does not lend itself to the manufacture of the smaller and more delicate type; in part by a sporadic survival of a ruder form in contemporary use with the later type, as commonly happens; and in some cases by the misinterpretation of nuclei as implements. Further, only isolated examples of the so-called early types are found instead of series of implements which could be referred as a whole to any one of the Early Palæolithic cultures, as should be the case had they really belonged to such a culture.

Pottery Styles and Periods in Peru.—Mr. A. L. Kroeber describes in vol. 21, pts. 5 and 6, of the *University of California Publications in American Archæology and Ethnology*, two more of the collections of Peruvian pottery made by Dr. Uhle and now in the University Museum—one from Moche and one from Supe. These Dr. Uhle himself assigned to four periods at Moche. Proto-Chimu, red and white ware associated with long skulls, Tiahuanaco and Epigonal; post-Tiahuanaco, black ware and, possibly separate, red, white, and black ware; and Chimu, black ware with Inca admixture. In the course of his analysis of this material to test Uhle's conclusions, Mr. Kroeber discusses the question of how far distinct style is necessarily proof of distinct period in time—a question of considerable general interest. He finds that, so far as pre-Hispanic America is concerned, there is abundant evidence that distinct styles did repeatedly co-exist. Thus at Pachacamac, Uhle's Tiahuanaco and Epigonal, though valid stylistically, are found in association, and good and debased Tiahuanaco are found in the same household. As regards periods traceable through a large part of Peru, not more than four are at present recognisable These are: pre-Tiahuanaco, including proto-Nazca, proto-Chimu, early Ancon (shell-mound), and probably Supe shell-mound styles, advanced in development in northern, and backward in central Peru; Tiahuanaco and Tiahuanacoid (Epigonal); pre-Inca era, a period, like the first, of local styles, some vigorous and original, others degenerate, though no sharp line can be drawn between this and the Tiahuanaco styles; and lastly, the Inca era, which includes not only classical Inca styles, but modified and mixed Inca styles such as late Chimu. All known styles of Peruvian pottery can be fitted into these eras.

European Corn Borer in the United States.—Among the numerous bulletins and papers issued on the European corn borer in America, the most recent that has come to hand is by Mr R. H. Pettit. He writes on the status of this insect in Michigan in *Circ. Bull 70 Agri. Expt Station, Michigan State College of Agriculture* (Nov. 1925). This State is threatened by the increase of the corn borer, like so many other parts of the United States. No measure in the light of existing knowledge can prevent the pest from eventually establishing itself wherever corn is grown Probably the worst infestation up to the present time has occurred in Ontario, where in some cases fields have shown a total loss. The author lays stress upon the value of State quarantine and the adoption of certain defined farm practices as affording the only possible means of restraining the insect, as it is too early to hope for results from parasite introductions.

Hibernation of a Succinea.—Dr. S. L Hora (*Records Indian Mus.*, 27, part v, Sept. 1925) gives a short account of the hibernation of a Succineid mollusc, *Succinea arboricola*. Living specimens were found at the end of August 1924 adhering very tenaciously to the bark of mango trees, and in form and coloration resembled wart-like outgrowths of the bark. Dead vegetable growth, chiefly of lichens, covered the bark and also the shells, which were very difficult to see, and in fact were first discovered by mere chance. When a specimen was forcibly detached a scar remained on the bark and a thin white epiphragm was found to cover the aperture of the shell. On removing the epiphragm the animal was seen to be in a comatose condition Other specimens were found on the under surface of leaves of the mango; they were sluggish, but their shells were not covered with vegetable growth. The peculiarity about this species is that it is found in a comatose condition during the rainy season, when most of its relatives are known to be active. The rainy season at Lonavla (in the Western Ghats), where the specimens were collected, is very long and the annual rainfall about 400 inches, and the author suggests that the peculiar habit of hibernation during the rains is a device for protecting the animal from being washed down by heavy rains. Dr. H. S. Rao gives an account of the anatomy of this new species.

The Vredefort Granite.—In the *Trans Geol. Soc. S. Africa* (vol. 28, 1925, p. 135), Dr A L Hall brings forward convincing evidence to show that the Vredefort granite is not intrusive into the Witwatersrand system, and is therefore not responsible for its metamorphism. The granite bears no resemblance to the Buschveld granite, but is more like the 'Older' granite of South Africa. Its outcrop covers a circular area twenty-five miles in diameter, and surrounding it is a concentric girdle of amygdaloidal lavas now converted into a granulite. Above the basal amygdaloid are the Lower Witwatersrand formations, which have also become intensely metamorphosed. Two causes in succession appear to be responsible for the metamorphism: (*a*) regional static metamorphism, due to the load of overlying sediments, and aided by the additional pressure generated during the updoming of the area; and (*b*) local thermal metamorphism, eccentric to the Vredefort granite, and due to the intrusion of a younger, still largely concealed, igneous body, the presence of which is indicated by several exposed bosses of alkali granite. The second cause has reinforced the effects of the first by producing coarser crystallinity of the rocks in general, and increased abundance of some of the typical metamorphic minerals.

Platinum in Southern Rhodesia.—The recent discovery of platinum in the Transvaal has stimulated interest in the possibility of finding payable platinum deposits in the norite of the so-called Great Dyke of Southern Rhodesia. Nearly twenty years ago, Mr. F. P. Mennell suggested that this enormous intrusion appeared to form a promising belt of country to prospect for platinum, and his prophecy has now been justified by the discovery of the metal in three large areas. A publication of the Southern Rhodesia Geological Survey (Short Report, No. 19, March 1926) by Mr. B. Lightfoot is devoted to the description of these areas and the associated rocks. The intrusion is composed essentially of the four minerals labradorite, augite, enstatite, and olivine, producing by their possible combinations fifteen different types of rocks. The platinum occurs, as in the Transvaal, in bands of pyroxene-rich norite containing disseminated sulphides and overlain by felspar-rich norite. The intrusion appears to be a greatly elongated laccolith, possibly fed by a true dyke below. Pronounced joint planes dip towards the 'Dyke' in many localities along its course, suggesting that the invaded granite lies beneath the flanks of the intrusion on both sides. The actual structure has long been a puzzle to geologists, and as it has now become of economic as well as of scientific importance, since it enters into the question of the future development of both chromium and platinum ores, it is likely soon to be further elucidated as prospecting work proceeds.

Arctic Ice in 1925.—The Danish Meteorological Institute has published its annual report on the state of the ice in the Arctic seas. As usual, the data are most numerous from the Barents Sea, Spitsbergen, the west coasts of Greenland and Alaska, but in 1925 a good deal of information was available from the east coast of Greenland. From the Beaufort Sea and the coast of Siberia practically no data came to hand. The most notable feature of the year was the unusually small amount of ice observed in practically all the Arctic seas that were visited. During the summer, the Barents Sea was free from ice and the Kara Sea was remarkably open. Spitsbergen waters were very clear, and during August there was open water round practically the whole of the group. Franz Josef Land, as usual, was more or less inaccessible, but there was open water on the north of Novaya Zemlya in August. On the east coast of Greenland the ice-belt was narrow, and there appears to have been less drift from the north than usual. Bering Strait was open in June, but the north coast of Alaska not until late in July. Commander C. I. H. Speerschneider, the editor of the report, comments on the facts that for several years, and particularly in 1925, little old ice was found in the east Greenland or east Spitsbergen currents, and that most of the ice was of one winter's formation. The report is illustrated with distribution charts for the months of April until August.

Vapour Pressures of Hydrogen Cyanide.—A series of vapour pressure measurements of solid and liquid hydrogen cyanide is published in the *Journal of the American Chemical Society*, February. The observed values are compared with those obtained by calculation and, in the case of the liquid, with some isolated results of previous works. Values of the latent heats are given which have been calculated from the Clapeyron equation.

Protein Digestion by Enzymes.—Under the general guidance of R. Willstätter, German chemists are making a great effort to isolate purer enzyme preparations, and in *Die Naturwissenschaften* for Feb. 19, 1926, Ernst Waldschmidt-Leitz gives a general account of the manner in which work of this type with proteases tends to modify current views as to protein hydrolyses by enzymes. By a laborious method of fractional precipitation, ereptase and tryptase have been obtained completely free from contamination with each other, and a study of their catalytic action has necessitated the revision of earlier conclusions drawn from work with less pure enzyme preparations. It is now found that ereptase is without action upon any but simple di- or tri-peptides; peptones, etc., being left quite unattacked. In addition to ereptase, the conclusion is drawn that at least three other types of protease must be distinguished, namely, peptase, tryptase not activated by enterokinase which is without action on the more complex proteins, and tryptase with enterokinase, a system which will attack such proteins. On the other hand, working with these purer enzymes, the ereptase from different sources appears to be identical in nature, and the differences reported in the behaviour of the same protease towards synthetic and naturally produced polypeptides have disappeared. In the light of this experimental study of proteases with which he has been associated, Waldschmidt-Leitz points out that the constitution of the protein molecule may have to be reconsidered from the point of view that it contains different types of chemical linkage, accessible to different types of hydrolytic enzyme.

Shock-Waves of High Explosives.—Certainly one of the most interesting and suggestive of the papers issued by the Safety in Mines Research Board is that numbered 18, "On the Pressure-Wave sent out by an Explosive," by Messrs. W. Payman and H. Robinson. To investigate the nature and the velocity of the invisible 'shock-waves' transmitted through the air by the sudden expansion of a confined volume of gas, the authors employed a modification of the 'Schlieren' method first developed by Töpler. The light of a brilliant, but very rapid, spark from a battery of Leyden jars is focussed on to a camera by means of a concave mirror of stainless steel—the beam of light crossing the field in which the shock-wave is transmitted. In front of the camera an opaque diaphragm is fixed so as to cut off the light from one half the lens. When a wave of compressed gas passes between the mirror and the camera, the light passing through it is refracted so that one half the beam is stopped by the diaphragm and the other half enters the lens. One half of the image of the wave comes out bright on the photograph and the other half is dark. With this apparatus photographs have been taken of the shock-waves produced both by the sudden release of compressed gases and by the firing of gas-mixtures and of high explosives. The authors have caught a shock-wave, started from a spark-ignition in electrolytic gas, as it emerges from a tube ahead of the flame, and in succeeding photographs have shown the flame overhauling this pressure-wave and swallowing it up in the explosion-wave. The photographs beautifully illustrate the slowing down both of shock- and explosion-waves as they emerge from a tube and develop spherical waves. They show also the heating effect when a shock-wave strikes an obstruction—and this will form the main subject of the large-scale experiments to be carried out on the shock-waves produced by firing modern explosives in coal.

Production and Properties of Large Single Crystals of Metals.

THE study of matter in the crystalline state is of importance at the present time to workers in so many branches of the pure and applied sciences that a paper by P. W. Bridgman, in vol. 60 of the *Proceedings of the American Academy of Arts and Sciences* of October 1925, on "Certain Physical Properties of Single Crystals of Tungsten, Antimony, Bismuth, Tellurium, Cadmium, Zinc, and Tin," will be read with far more than usual interest. With the exception of tungsten, all these metals crystallise in systems other than cubic, zinc and cadmium being hexagonal; bismuth, antimony, and tellurium trigonal, and tin tetragonal. The tungsten crystal, prepared in another manner, was included in the research merely as a result of the fact that a large crystal was placed at the author's disposal.

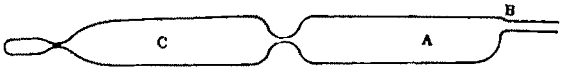

FIG. 1.—The mould used in producing single crystals.

Although much work has been done on single crystals of metals lately, the major portion has related to crystals which have been produced by some form of mechanical treatment followed by an appropriate annealing. It is not yet definitely known to what extent the mechanical deformation has impressed on the material specific characteristics which have persisted despite the reheating. Work, therefore, which is done on virgin crystals, never at any stage of their history stressed above their elastic limits, is not only of fundamental interest in itself, but has also a by no means unimportant value in connexion with the interpretation of results obtained on crystals produced by some form of work.

The method used by the author, by means of which single crystals up to nearly an inch in diameter have been made, consists in melting the metal in a suitable mould of quartz or refractory glass tubing and allowing the tube to pass slowly out of the furnace into the air or into a bath of oil. Solidification then starts at the bottom of the tube and proceeds slowly upwards, keeping pace with the lowering. If this be sufficiently slow, and provided that only one nucleus forms at the bottom of the tube, the metal will usually crystallise as one grain, having the cylindrical shape of the mould. This still holds even where the metal passes through an allotropic change point between the temperature of solidification and that of the room. Further, it is of interest that in almost all cases, especially where the diameter of the tube is fairly great, the crystal formed has the plane of easiest cleavage, or slip, parallel to the axis of the casting.

Various details require attention if consistent success in the production of a single crystal is to be attained, and the shape of the mould finally used is indicated in Fig. 1. The bottom of the tubing is drawn down to a separate chamber connected to the main part *C* by a capillary 0·1 mm. or so in diameter. This fine orifice acts as a 'filter,' allowing one only of the several grains which may have formed to pass through into the mould proper. It is essential that fresh nuclei should not form in *C*, which demands complete freedom from particles of oxide or specks of dirt. The melting of the metal, therefore, is done in a pre-melting chamber *A* connected with *C* by another capillary and provided with a tube *B* by means of which the metal may be introduced in the first place, and by which connexion may later be made with a vacuum pump, allowing the metal to be melted without oxidation. The process employed thus consists of first placing in *A* the metal to be examined, evacuating the vessel and placing it in a horizontal position in an electric furnace. It is essential that all traces of gas should be removed from the melt, and this is done by rocking the furnace and washing the metal backwards and forwards in *A*. Bismuth is particularly difficult to free from the last trace of gas, and it may be necessary to manipulate the molten metal for an hour or more before all has been eliminated. The furnace is now rotated into a vertical position and the metal allowed to filter into the mould, admitting air, or some other gas under pressure, to accelerate the process. The mould may now be lowered from the furnace at a speed depending on the metal and the size of the casting. For crystals of 2·2 cm. diameter a speed so low as 4 mm. per hour is desirable, while for small castings, 60 cm. per hour may be used. Except for bismuth and tellurium, however, there is no danger in using too small rates of lowering. A shield to prevent draughts striking the tube is helpful and, in the case of cadmium, cooling in a bath of oil is preferable to cooling in air. To prevent the metal sticking to the mould, the latter is treated with oil before use; this is then removed with ether, and the latter removed by evaporation with a gentle flame played on the surface.

TABLE.

SUMMARY OF RESULTS.

Metals *	Initial Linear Compressibility at 30° C. Pressure Unit 1 kgm./cm.².	Elastic Constant C G S	Linear Thermal Expansion at 20° C.	Specific Resistance 20° C.	Average Temperature Coefficient of Resistance 0-100° C.	Initial Pressure Coefficient of Resistance at 0° C. Pressure in kgm
Zinc II	$12·98 \times 10^{-7}$	$26·38 \times 10^{-12}$	$57·4 \times 10^{-6}$	$6·13 \times 10^{-6}$	0·00419	$-10·87 \times 10^{-6}$
I	1·95	8·23	12·6	5·91	0·00418	− 6·55
Cadmium II	18·3	36·9	52·5	8·30	0·00428 (?)	−15·1
I	2·1	12·9	20·2	6·80		− 8·7
Bismuth II	15·92	28·7	13·96	138	0·00445	+24·5
I	6·62	26·9	10·56	109		+ ·75
Antimony II	16·48	33·8	15·56	35·6	0·00595	+17·2
I	5·26	17·7	7·96	42·6	0·00511	+ 1·05
Tellurium II	−4·14	25·4	−1·6	56000	—	—
I	27·48	48·7	27·2	154000	—	—
Tin II	6·72	11·8	30·50	14·3	0·00447	−10·96
I	6·02	18·5	15·45	9·9	0·00469	−10·28

* II, in a direction parallel to the axis of rotational symmetry.
I, in a direction perpendicular to the axis of rotational symmetry.

In the examination of the crystals, it was necessary to determine the orientation, and a very simple manner in which this is done is described, depending on the small 'negative' crystalline facets formed on the surface, the necessity of resorting to X-ray examination being avoided.

A short list of the more important values obtained will be found in the table above, but there are very many points of general interest which are recorded. The author agrees with other workers in mentioning that the elastic limit of many of these single crystals is often "unbelievably" low. It is much to be regretted that so far no attempt has been made to examine the behaviour of the crystals at stresses higher than the elastic limit, an aspect of the work which is much to be desired.

It will be seen from the table that, broadly, the linear compressibility, the extension under tension (save in the cases of tin and tellurium), the thermal expansion, and the specific resistance are greater in a direction along the axis of rotational symmetry than in one at right angles. There are certain exceptions, however, and for tellurium the compressibility along the trigonal axis is negative, so that on subjecting the crystal to hydrostatic pressure it actually elongates in that direction; in the same direction also this element has a negative value for the thermal expansion. Antimony also furnishes an exception to the last of the generalisations, though here the exception may be regarded as being of a temporary nature, since at high pressures the metal becomes normal. With the exception again of antimony, which, however, behaves normally when the pressure is sufficiently increased, the temperature coefficients of resistance are not much affected by the orientation of the crystal. The effect of pressure on the resistance is, however, more affected by the direction of the current It may be noted that, although pressure diminishes the resistance of cadmium, zinc, and tin, it increases that of both bismuth and antimony. In general, the statement may justifiably be made that the electrical properties show much less variation with the orientation of the crystal than do the mechanical ones.

Little work is recorded so far as the magnetic properties of these crystals are concerned, but a few, by no means uninteresting, observations are made. In the cases of bismuth and antimony there is a very definite directional effect. Bismuth sets itself with the trigonal axis parallel with the lines of force, the permeability being greatest along this axis, thus confirming the observation first made perhaps by Tyndall In the case of antimony the crystal arranges itself with the cleavage plane parallel to the lines, the effect being even stronger than that in the case of bismuth. Tin also showed rather curious properties. On making the field (about 15,000 gauss) there was no observable effect, but when the field was broken, a kick occurred in such a direction as to tend to cause the tetragonal axis to come into line with the magnetic field. When the axis was already aligned with the field this kick was not shown.

The results of the specific resistance measurements are of general interest in connexion with the resistances of aggregates of the same metals. Knowing the specific resistances for a crystal along and perpendicularly to the axis of rotation $\rho_\parallel$ and $\rho_\perp$ respectively, Voigt has shown that the resistance ρ of a haphazard aggregate should be given by the equation

$$\frac{1}{\rho}=\frac{1}{3}\left[\frac{2}{\rho_\perp}+\frac{1}{\rho_\parallel}\right].$$

This calculated value for the aggregate is given in several cases and is consistently lower than that directly determined. Thus for cadmium the value for the aggregate thus calculated is $7 \cdot 24 \times 10^{-6}$ ohms per cm. cube, while observed values are 7·51 and $7 \cdot 54 \times 10^{-6}$ ohms. Again, for tin, the results give a calculated value for the aggregate of 11·06 microhms per cm. cube against the determined figure (Bureau of Standards) of 11·5 ohms. The author[1] explains the differences by assuming that his own material was purer than any hitherto measured, which to some extent may be sufficient. There is, however, an alternative explanation. In the aggregate there are crystal boundaries the resistance of which, it is highly probable, is higher than that of the crystalline matter itself. The calculations in the paper under review cannot take into account any such changes brought about by boundary conditions within the mass, and the differences between the calculated values and those observed may therefore be regarded as offering confirmation of the idea that the crystal boundaries are regions of relatively high electrical resistance.

Prof. Bridgman's work has also fully demonstrated the fact that under pressure cadmium can be transformed first into one and then into a second allotrope. One such transformation had already been suspected, for example by Greenwood, but the new work makes the transformation certain and shows that two changes can be induced. The space lattices of the new forms are not yet known, but there is here in some ways the first absolutely direct evidence that under stress a change of lattice may be produced. In Fig. 2 the effect of temperature on the stress required to effect the modification is shown. Volume changes of the order of 2 per cent. may occur, which may be either positive or negative. At first the transformations are more or less reversible, but after several changes of (hydrostatic) pressure in reversed directions, the discontinuity usually becomes gradually less marked and finally almost disappears.

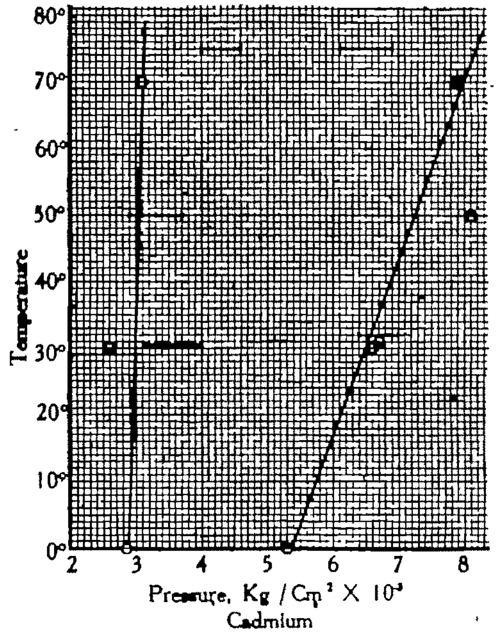

FIG. 2.

Finally, there are two statements which are of importance in connexion with the crystallographic changes which occur when a metal is forced through an orifice. In extruded wires of cadmium, the properties suggest that there is a preponderance of crystals with the hexagonal axis lying more or less parallel to the axis of the wire Tin shows a similar effect very clearly. The temperature coefficient of specific resistance of a single crystal, for example, measured in a direction parallel to the tetragonal axis is 0·00447 and perpendicular to this axis 0·00469. The corresponding value obtained for an extruded wire of Kahlbaum tin was 0·00447, *i.e.* that which would be obtained if this wire was so orientated that the tetragonal axis of all the constituent crystals had been rotated into parallelism with the axis of the wire.

F. C. T.

The Courtship of Birds.

PROF. JULIAN HUXLEY and his co-workers have recently made some further contributions to the subject of the courtship of birds, dealing with three species of waders which were kept under close observation during two visits to the Texel

The extent to which special courtship performances are developed in the order differs widely as between one species and another. Thus, the avocet (J. S Huxley, *British Birds*, 1925, 19, 88) has no courtship at all. There is an invitatory attitude adopted by the female immediately before coition, responsive excitement on the part of the male, and a post-nuptial ceremony in which the pair run forwards together with the cock's half-spread wing over the hen's back—but of true courtship nothing.

On the other hand, the black-tailed godwit (J. S. Huxley and F. A. Montague, *Ibis*, 1926, 1) exhibits an elaborate courtship behaviour. There is a ceremonial flight accompanied by a special call, which is performed by the male and is probably associated with the territorial instinct. Then there is a tail display by the male, performed on the ground before the female, which is a true courtship activity. There is also a scrape ceremony, mainly performed by the male, which is obviously derived from the nesting instinct. Both birds, further, take part in a joint flight, and there is pursuit of the female by the male, hostility between rival males, and a coition ritual. The whole makes up a complex series of events.

The oyster-catcher (J. S. Huxley, assisted by F. A. Montague, *Ibis*, 1925, 868) seems to occupy an intermediate position in regard to the development of courtship activities. Special interest attaches to the piping performance, which consists of continuous piping while the neck is thrust forward and the head and the open beak are directed downwards: this may be accompanied by bobbing of the body or, more often, by dancing movements. It is shown that this is not of purely courtship significance, and that it is performed by both sexes and in varying circumstances. "It may be merely an expression of general sexual excitement, performed by a single bird without special relation with other birds. Or it may be a display definitely directed at another bird, which may or may not be the mate, and may or may not join in; or it may be a definite sign of hostility, either by one bird of a pair to a single intruder of the same sex, or by one pair to another. Or, finally, it appears that sometimes, where hostility might be expected, extra birds may be allowed to join a performance, in which case social excitement also seems to come into play."

The League of Nations Cancer Inquiry.

THE death rate from cancers of the breast and uterus in England is much higher than it is in Holland or Italy. The Health Organisation of the League of Nations appointed an international committee, with Sir George Buchanan as chairman, and also a committee of statisticians, presided over by Dr. M Greenwood, to look into the matter, and the first results have now been published[1] The greater part of the reports is occupied by elaborate statistical surveys of the available data for England by Dr. Greenwood, for Holland by Dr H. W. Methorst, and for Italy by Prof. A. Niceforo, and their analysis is directed particularly to the relation of marriage age and place to the incidence of these forms of cancer. The non-technical reader will find the introductory summary easier to follow, and there is room for a still simpler abstract which, with a few diagrams, would deserve wide circulation among medical men

The Committee finds that the three countries differ in their mortalities as stated, and significant differences of rate occur in the different divisions of each country: in England, cancer of the breast is most prevalent in the east and south, in Holland on the western coast, in Italy north of Rome The Committee agrees in providing very full confirmation of the belief that cancer of the breast falls most heavily on unmarried women, cancer of the uterus on those who have been married. It is also shown definitely that women who develop cancer in either site are less fertile than those who do not.

These results are something more than confirmations of what was already known or suspected, for they are based on such comprehensive considerations that they reach an order of validity, exceptional in medical literature, which makes it necessary that any hypothesis on the cause of cancer should not be incompatible with, and should ultimately explain, them. Having securely established the facts, the Committee proceeded to look for an explanation of them. So far the results of this inquiry have been uniformly negative: the circumstances investigated have been; those personal factors which are dealt with in hospital records, more may be obtained when the domestic and social sides of life are considered. The whole report is an excellent example of what the League can do in such matters, and we hope for much more of the same kind of solid work.

University and Educational Intelligence.

ST. ANDREWS.—The Senatus Academicus has resolved to confer the Honorary Degree of LL.D. on Dr. E. F. Armstrong, Director of the British Dyestuffs Corporation; Dr. George Forbes, distinguished by his pioneer work in electrical engineering and popular writings on astronomy; Mr. E. S. Harkness, of New York, founder of the Commonwealth Fund; and Prof. E. T. Whittaker, professor of mathematics and Dean of the Faculty of Arts in the University of Edinburgh. The degrees will be conferred at the Graduation Ceremonial to be held on June 29.

THE Air Ministry announces that Sir Charles Wakefield, Bart., has generously offered to continue the 'Sir Charles Wakefield' Scholarships, founded by him in 1920. These scholarships are each of 75*l*., tenable for one year at the R.A.F. Cadet College, Cranwell, and are intended to give financial assistance to successful candidates for entry into the College. Two scholarships are awarded at each half-yearly entry. One of these is awarded on the result of the open competitive examination for admission to the Cadet College held in June and November, and the other to one of the aircraft apprentices who at the conclusion of their training at the R.A.F. training establishment at Halton are selected twice a year for flight cadetships at Cranwell.

THE Ministry of Agriculture and Fisheries is prepared to receive by, at latest, May 15, applications for grants in aid of scientific investigations bearing on agriculture to be carried out in England and Wales during the academic year beginning October 1, 1926. A prescribed form of application (A.*53/TG) giving particulars of the conditions under which the grants are offered, may be obtained from the Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 The Ministry also invites applications for a number of research scholarships in agricultural and veterinary science which will be tenable for three years and be of the annual value of 200*l*, plus, possibly, allowances for travelling and subsistence abroad. Copies of application form 900/TG are obtainable from the Secretary, and must be returned not later than June 30.

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[1] Société des Nations: Organisation d'hygiène, sous-comité du Cancer. Rapport sur les résultats des enquêtes démographiques dans certains pays. (C.H. 333, Vol 1.) Pp. 168 Rapport sur les résultats de certaines enquêtes, clinique se rapportant aux différences de mortalité cancéreuse dans certains pays choisis spécialement. (C.H. 333, Vol. 2) Pp. 392. (London: Constable and Co., Ltd, 1925.)

WE have recently received the report for the year 1924-25 of University College, London, which shows a total student enrolment (3033) exceeding by 198 the total for the preceding year. The enrolment for the current session is likely to be still larger. The total includes 388 evening students and 214 attending vacation courses Excluding these there were 1911 undergraduate and 520 post-graduate and research students. More than one-fifth came from homes beyond the British Isles, including 230 (83 post-graduate and research) from various parts of the Empire. India and Ceylon contributed 124 (43), Australia 24 (14), Canada 10 (5), New Zealand 12 (7), South Africa 27 (7), the figure in brackets indicating the number of research students. Among foreign countries, the United States of America were represented by 52 (24), Japan by 41 (11), Germany by 51 (3), Switzerland by 39 (1), France by 32, Holland 21 (2). The large number (148) of post-graduation and research students from beyond the British Isles is noteworthy. Free public lectures have for many years been a conspicuous feature of the work of the College. In 1924-25 they were attended by more than 6,000 persons. The list of appointments in other countries obtained by members of the College, staff and students, during the year includes professorships at McGill, Dalhousie (Halifax), Mysore, Cape Town, and Vassar.

IN a pamphlet entitled "The New University of Reading: some ideas for which it stands," Principal W. M. Childs gives prominence to the idea that the collegiate or residential principle, so characteristic of Oxford and Cambridge, is indispensable to the fulfilment of the highest functions of a university. Among these functions is training in character and living as well as opportunity for acquiring knowledge, and the corporate life of the students is the most favourable medium for such training. An instructive parallel is drawn between the academic and the economic worlds: "The whole world is sick because in getting rich and progressive something essential to human contentment has been lost or greatly mutilated; namely, personal relations. . . . Is it proposed to transfer this sickness from the sphere of economics to the sphere of education?" If not, it is essential that conditions should be favourable for the development of individual personal contact of teacher with student, and student with student The residential halls of Reading, accommodating no less than 70 per cent. of the full-time students, represent the greatest achievement of the movement for establishing such conditions in the modern provincial universities and university colleges. Another subject dealt with in the pamphlet is "Universities and Research," in connexion with which attention is directed to the recent constitution of a Research Board with a general responsibility and mission for promoting and stimulating research in fields other than that covered by the work of the National Institute for Research in Dairying (which is a part of the University of Reading) and of administering to that end funds entrusted to it by the Council (for 1925–26, 500*l*.).

Contemporary Birthdays.

April 17, 1863.	Dr. George Grant MacCurdy.
April 21, 1871.	Sir Sydney John Chapman, K C.B.
April 22, 1840.	Mr. Richard Inwards.
April 23, 1869.	Prof. Percy Edward Newberry.
April 24, 1841.	Prof. Charles Sprague Sargent.

Dr. MACCURDY, the distinguished American anthropologist, was born at Warrensburg, U.S.A. Graduating at Harvard, he studied afterwards at the Universities of Vienna, Paris, and Berlin. His connexion with Yale University dates back some thirty years Since 1923 he has been accorded the status of professor and curator of the anthropological collections in Yale. Dr. MacCurdy was the first director (1921) of the American school in France for prehistoric studies. He is the author of "The Eolithic Problem" (1905), and "Human Origins" (1924, 2 vols.).

Sir SYDNEY CHAPMAN, permanent secretary of the Board of Trade since 1919, was born at Wells, Norfolk. He was educated at Manchester Grammar School and Owens College, graduating from thence at Trinity College, Cambridge. Lecturer in economic and political science in the University of Cardiff from 1899 until 1901, he returned to Owens College to take up the post of professor of political economy, retaining this for sixteen years Sir Sydney was president of Section F (Economic Science and Statistics) at the British Association's Winnipeg meeting in 1909. The general topic of his address related to the value of leisure, the bearing of industrial development upon it, and its effectiveness in shaping economic arrangements. He has been a recipient of the Guy medal of the Royal Statistical Society.

Mr. INWARDS was born at Houghton Regis For many years engaged in mining engineering and kindred enterprises in Bolivia, Mexico, and other parts of the world, he finally settled in England. Joint editor for two decades of the *Quarterly Journal of the Royal Meteorological Society*, he was the Society's president in 1894–95.

Prof. PERCY NEWBERRY, honorary reader in Egyptian art at the University of Liverpool, was educated at King's College School, London, and King's College. Beginning the study of Egyptology in 1884, his acquirements and exactitude in procedure qualified him to be officer in charge (1890) of the archæological survey of Egypt, conducted under the auspices of the Egypt Exploration Fund. Brunner professor of Egyptology in the University of Liverpool from 1906 until 1919, Prof. Newberry was president of Section H (Anthropology) at the British Association's meeting in that city in 1923. He gave an address on "Egypt as a Field for Anthropological Research."

Prof. SARGENT, the veteran American botanist, who is a foreign member of the Linnean Society of London, was born at Boston, U.S.A., and graduated at Harvard University. Sometime director of the Boston Botanic Gardens, it was Sargent who organised the Jesup collection of North American woods for the American Museum of Natural History, New York. He was one of the commissioners (1896) detailed to report upon a forest policy for the forestry lands of the United States. He is the author of "A Manual of the Trees of North America," and "The Forest Flora of Japan."

Societies and Academies.

London.

Linnean Society, March 4.—**E. Heron-Allen**: The iconography of a myth. The legend that the stalked barnacle, *Lepas anatifera*, upon trees overhanging the water, or upon rotten timber, and, at maturity, produces a goose or duck, permeates scientific literature from the eleventh to the seventeenth centuries, and since the invention of printing has been fancifully illustrated. The myth appears to have passed current in the Near East in 1000 B.C., and is illustrated upon Mykenæn pots.—**C. J. Stubblefield**: Notes on the development of the trilobite, *Shumardia pusilla* (Sars). A large number of complete specimens have been collected, ranging in length from 0·24 mm. in the earliest or 'Protaspid Period' to 4·91 mm. in the latest or 'Holaspid Period.' The six thoracic segments are released one by one from dorsal fusion in the posterior shield or 'transitory pygidium' *S. pusilla* offers new evidence in favour of the hypothesis, advanced by Beecher in 1896, that the growing point of the new segments in trilobites was in front of the most posterior or anal segment.—**H. Graham Cannon**: On the post-embryonic development of the fairy shrimp (*Chirocephalus diaphanus*). The development of *Chirocephalus diaphanus* is essentially similar to that of Estheria. Cœlomic sacs are formed as in the latter, but do not attain any considerable size owing to the precocious development of the pericardial cavity. The method of heart-formation differs in different parts of the body. The development of the maxillary gland shows no essential differences from that of Estheria. The antennal gland shows very clearly, between end sac and duct, a sphincter consisting of three cells connected directly to the cuticle. The musculature is more complex than that of Estheria, there being a series of 'connective muscles' between the dorsal and ventral longitudinal muscles. The dorso-ventral muscles, the proctodæal dilators, and probably the stomodæal dilators are of ectodermal origin.—**H. W. Pugsley**: Further notes on Fumaria and Rupicapnos. The material, largely the fruit of recent French botanical expeditions into parts of Morocco hitherto unexplored, has yielded some new species both of Fumaria and Rupicapnos. New forms were also discovered in Algeria during a visit to that country in 1922.

Geological Society, March 10.—**J. E. Marr**: The Pleistocene deposits of the lower part of the Great Ouse Basin. A period of aggradation in Lower Palæolithic times intervened between two periods of glaciation of the district, and after the second glaciation, erosion occurred, with minor periods of aggradation in Upper Palæolithic times. An appendix by **A. S. Kennard** and **B. B. Woodward** deals with the non-marine mollusca.—**W. G. Woolnough** and **Sir T. W. Edgeworth David**: Cretaceous glaciation in Central Australia. Evidences of glacial action in Central Australia were recorded more than forty years ago, mostly in the form of numerous erratics and occasional beds of tillite. The occurrences are now known to belong to two distinct geological horizons, the older almost certainly Permo-Carboniferous, and the newer probably Jurassic to Cretaceo-Tertiary. Recently, one of the authors (W. G. W.), when exploring the salt-lakes of Central Australia on behalf of Brunner, Mond and Co., discovered good evidence as to the age of the later glaciation. The most recent expedition (by W. G. W.) has led to the discovery by him of marine fossils in the same matrix as that in which the erratics are embedded. The erratic-bearing beds, together with a thick series of freshwater strata with lignites, which mostly overlie the glacial deposits, are termed the Winton Series. They are followed by strata making locally a distinctly unconformable junction with them and probably of early Tertiary age. These latter beds belong to the Eyrian Series, which in places carries fossil leaves of Eucalyptus. F. W. Whitehouse opines that the age may approximate to Albian. If so, it would accord with the New Zealand evidence of a great orogenic movement in those islands soon after the close of Neocomian time. It is suggested that the crust-movements, which were orogenic in New Zealand, expressed themselves as epeirogenic uplifts in Australia and accounts for the fact that the Cretaceous Mediterranean of Australia gave place soon after the close of Aptian time to a vast freshwater lake: for marine sedimentation, although in places represented by small patches of Albian, mostly ceased even before Albian time.

Physical Society, March 12.—**A. H. Davis**: The analogy between ripples and acoustical wave phenomena. The analogy between cylindrical sound waves and waves on the surface of a liquid is studied. For inviscid media, as regards velocity potential, the differential equations are similar provided the disturbance is small and is harmonic in type. The effect of moderate viscosity is of the same type for sound waves and for surface waves; it is most marked for short wave-lengths, and it decreases amplitudes without appreciably altering the wave-length. Viscous effects are generally negligible in the case of sound, but they are appreciable for the water waves that would usually be used in a small ripple tank not greater than, say, 10 feet in size. Mercury waves are much less affected by viscous damping than water waves. Experiments with model obstacles in a ripple tank show that the effects of the meniscus around the obstacle and of the amplitude of the source are not important. When the water becomes stale on exposure—and presumably contaminated—the relative distribution of ripples around obstacles is appreciably modified, but not to an extent which would correspond to any very marked change in the loudness of a sound. Experiments have also been conducted using an impulsive disturbance instead of a maintained train of waves. When it is recognised that a sound pulse travels out singly, whereas with ripples subsidiary wavelets accompany the main pulse, the correspondence between ripple photographs and sound pulse photographs is most striking.—**R. M. Archer**: On the evaporative losses of vacuum-jacketed vessels of the Dewar type. The evaporative losses of metal Dewar vessels are discussed, and particulars given of experiments made by the author in Oxygen Laboratory of the Air Ministry. The separation of neck and radiation losses is described, and also a method of testing adsorbents under working conditions.

Cambridge.

Philosophical Society, March 15.—**A. Sommerfeld**: Some controversial points in the theory of spectra. (Lecture.)—**J. A. Crowther**: A theory of the action of X-rays on living cells.

Manchester.

Literary and Philosophical Society, March 9.—**G. Elliot Smith**: The brains of apes and men (Wilde Memorial Lecture). Without the cultivation of manual dexterity, which involves the aptitude to learn by experimentation, man's ancestors could not have acquired the seeing eye and the understanding ear. Man's intellectual pre-eminence is based upon his ability really to see the things and events around him, to understand something of their significance and to appreciate their æsthetic qualities. Vision became also the chief instrument for determining his sexual selection and affecting his social behaviour in an infinite variety of ways. But it affects human thought and action in much more subtle and obtrusive ways. Apart altogether from the phenomena of consciousness, it helps unconsciously in controlling posture and regulating the tone of muscles, a function upon the effective performance of which skill is so largely dependent. The attainment of the erect attitude in the human family was intimately bound up with the increasing influence of the eyes and the cerebral cortex in the control of posture. The special interest of the apes' brains is that they provide the evidence to help us to get some idea of how vision acquired its ascendancy. The casts obtained from the brain-case of extinct members of the human family—in particular those of Pithecanthropus, Eoanthropus, and the Rhodesian man—provide important evidence in confirmation of the fact that the processes of growth and elaboration of the brain, which can be studied in the lowlier primates, were continued within the human family itself. Moreover, they agree with the order of development of the cerebral cortex revealed in the brain of the modern child. The real importance of the interesting fossil ape found at Taungs in 1924 is that it reveals the earliest stage in this process of cerebral development and facial refinement.

PARIS.

Academy of Sciences, March 8.—**A. Lacroix**: The classification of leucite rocks: the types of the syenite family.—**C. Matignon** and **J. Cathala**: The action of phosgene on glucina. The work described by the authors in a recent communication was anticipated by Ed. Chauvenet in 1911.—**Ch. Moureu, A. Lepape, H. Moureu**, and **M. Geslin**: The composition (ordinary and rare gases) of the gases spontaneously evolved from some thermal springs of Madagascar and Réunion. Of the eleven waters examined, eight were from Madagascar, and all except one consisted mainly of carbon dioxide. All contained argon, but only one, from Ranomafana, contained appreciable proportions of helium (0·56 per cent.). The gases evolved were very similar to those obtained from the bicarbonate springs of the Central Plateau in France. This was rather unexpected, since the subsoil in the Antsirabé basin, from which seven out of eight of the Madagascar samples were obtained, is rich in radioactive minerals (betafite, euxenite, etc.), and consequently rich in helium.—**Léon Guillet** and **Jean Cournot**: The influence of thermal treatment on some silver alloys. A study of silver-zinc and silver-cadmium alloys. The alloys with zinc show very clearly the increase of hardening by reheating, in this resembling duralumin: for the silver-cadmium alloys the results are less evident.—**R. de Forcrand**: The action of thallium on alcohols or on dilute acids and on water and ethyl alcohol in excess. Thermochemical determinations.—**Jean Baptiste Senderens**: The etherification of the aromatic alcohols. Study of the conditions under which sulphuric acid can convert benzyl, phenylethyl (primary and secondary), and cinnamic alcohols into the corresponding ethers.—**R. Swyngedauw**: The velocity of the slack and taut fibres of a belt.—**J. Ottenheimer** and **R. Dubois**: A wave preceding the explosive wave.—**Marcel Laporte**: The measurement of the mobility of ions in gases. The method is analogous to that used by Fizeau for measuring the velocity of light. Experiments were conducted with air, oxygen, nitrogen, carbon dioxide, and argon. For all these cases it is necessary to conclude that there exist ions of different mobilities, the values of which are comprised between two clearly different limits. Values given by other experimenters fall between these limits.—**Max Morand**: Study of the working of a positive ray tube.—**G. Ribaud**: The influence of the external temperature on the temperature of standard pyrometric lamps.—**R. de Fleury**: Pistons of aluminium, alpax, and magnesium.—**W. Perschke**: The study of triboluminescence.—**P. Job**: The spectrographic study of trihalogen salts of potassium. The method described has indicated the existence of KI_3, KBr_3, $KBrI_2$, $KClBr_2$, and $KClI_2$.—**A. Bigot**: Kaolins, clays, etc. Formation of the clay schists of the coal measures.—**Clément Duval**: Preparations of the nitrite of *cis*-dinitrotetrammine and of some bodies derived from it.—**— Lespieau**: The action of acrolein on the mixed dimagnesium derivative of acetylene. One of the products of this reaction is a new penteninol $CH \equiv C - CH(OH) - CH = CH_2$, the physical and chemical properties of which are described.—**Marcel Guerbet**: The asymmetric dialkylarsinic acids and, in particular, methylethylarsinic acid.—**Mlle. Y. Brière**: The existence of uraninite (pitchblende) in certain pegmatites from Madagascar. Although many radioactive minerals have been found in Madagascar, this is the first occasion of finding pitchblende.—**M. Kovitch**: The existence of leucitic lavas in southern Serbia.—**A. Demay**: The tectonic signification of lustrous gneiss of the Pilat massif, near Saint-Etienne.—**Ch. Maurain**: Magnetic measurements in the west of France.—**Jean des Cilleuls**: The phytoplankton of the Loire.—**V. Lubimenko**: The physiological rôle of the starch deposited in the green parenchyma of leaves.—**H. Lagatu** and **L. Maume**: The diagnosis of the food of a plant by the chemical evolution of a suitably chosen leaf.—**A. Dognon**: The biological action of X-rays of different wave-lengths. Reply to a criticism by M. Dauvillier.—**P. Petit** and **Richard**: The mechanical liquefaction of starch paste.—**M. Bridel** and **C. Béguin**: The action of emulsin from almonds on *l*-arabinose in solution in ethyl alcohol of different strengths.—**G. Guittonneau**: The microbial oxidation of sulphur. Further experiments confirming the view put forward in an earlier communication that the first product of the oxidation of sulphur in soil by micro-organisms is a thiosulphate.—**Georges Truffaut** and **N. Bezssonoff**: The influence of metallic aluminium on the activity of nitrogen-fixing bacteria. Larger proportions of nitrogen are fixed in the presence of metallic aluminium.—**M. Marage**: The defence of the organism against medicaments.—**Roucayrol**: The action of diathermy in blennorrhagia.

VIENNA.

Academy of Sciences, February 4.—**G. Stetter**: (Communication of the Radium Institute, No. 181.) The determination of the ratio charge to mass for natural H-rays and atomic fragments from aluminium. (No. 182.) The components of the $K\beta_1$ line of iron.—**K. Przibram**: On the interpretation of the colour changes in salts; preliminary communication dealing with colours of alkali haloid crystals.—**P. Weiss**: (Communication of the Biological Experiment Institute of the Academy of Sciences in Vienna, No. 128.) The origin of the skin in regenerated extremities of *Triton cristatus*.—**L. Abolin**: (Communication of Biological Institute, No. 129.) Influence of chemicals on the colour changes of fishes. The influence of central and peripheral nerve-poisons on the whole chromatophore system of the minnow, *Phoxinus laevis*. Strychnine and other poisons produced a darkening of the fish due to expansion of the melanophores.—R. **Muller**, F. **Griengl** and J. **Mollang**: The electro-chemistry of nonaqueous solutions (vii.). Conductivity measurements in dilute solutions of silver nitrate in twelve organic solvents and determination of the limits of molar conductivity.—M. **Eisler** and L. **Portheim**: Further researches on hæmagglutinines in plants. Extract of the ripe seeds of *Phaseolus multiflorus* has the power of coagulating red blood corpuscles. Hæmagglutinin also occurs in seeds of *Ricinus communis*, seeds of *Datura Stramonium* and tubers of artichoke, *Helianthus tuberosus*.—V. **Oberguggenberger**: Earth current observations in the mountains.—F. E. **Suess**: The structure of variscic primitive rocks.

February 11.—T. **Kautz**: (Radium Institute, No. 183.) Determination of the half period of radium D by measuring the heat evolved by an old radium preparation.—E. **Rona**: (Radium Institute, No. 184.) Determinations of the absorption and range of natural H-rays.—E. **Gebauer-Fulnegg** and **Riess**: Quinone-sulphur-imines.—C. **Diener**: The fossil deposits in the Hallstatter limestones of the Salzkammergut.—L. **Kober**: New contributions to the geology of the eastern Tauern and the Salzkammergut.

February 18.—J. **Lense**: Special ametric manifolds.

Washington.

National Academy of Sciences (Proc. Vol. 12, No. 2, February).—Charles E. **St. John**: The red shift of solar lines and relativity. The general displacement of spectral lines towards the red required by relativity is found, but there are noteworthy discordances between theoretical and observed values. The deviations are correlated primarily not with intensity but with the level in the sun's atmosphere at which the lines in question are produced. Generalised relativity provides a general displacement due to the slowing-up of the atomic clock. The Doppler effect, due to radial movements in the solar atmosphere, explains systematic deviations of high- and low-level lines. Differential scattering, owing to the longer path in the solar atmosphere traversed by light from the limb, accounts for the increased displacement of lines from the limb (limb effect).—G. W. **Keitt**: Some relations of environment to the epidemiology and control of apple scab. Apple scab (*Venturia inæqualis* (Cke.) Winter) has been studied in the field and under controlled conditions. In Wisconsin, the fungus winters in infected leaves on the ground and in spring ascospores are shot out and carried by air currents to the trees, where infection is spread by conidia. The optimum temperature for infection and ascospore germination is about 20° C. Fluctuations in humidity have little effect. Sulphur fungicides are most effective against scab.—E. O. **Salant**: Infra-red absorption of the N-H bond. Examination of a series of symmetrical dialkyl and trialkyl amines indicates that the N-H bond has a characteristic fundamental vibration frequency varying between wave-numbers 1400 and 1700, according to the other atoms in the molecule.—F. R. **Bichowsky** and H. C. **Urey**: A possible explanation of the relativity doublets and anomalous Zeeman effect by means of a magnetic electron. It is assumed that the electron is a charged magnetic doublet of the magnetic moment of half a Bohr magneton and the perturbing effect of other electrons is neglected. Half-quantum numbers are adopted, the total magnetic moment of an atom being assumed to be contributed half by the electron rotating on itself and half by its rotation round the nucleus.—F. **Zwicky**: Theory of the specific heat of electrolytes.—T. **Lyman** and F. A. **Saunders**: The spectrum of neon in the extreme ultra-violet. Lines between $\lambda 630$ and $\lambda 590$ appear to be due to normal neon (Ne I); the spectrum of ionised neon (Ne II) extends to $\lambda 430$.—Arthur J. **Dempster**: The free path of protons in helium Protons accelerated through 900 volts potential difference pass freely through atoms of helium with only slight changes in velocity or direction. It is suggested that these protons, having much smaller velocities than the electrons in the atom, cause only a slow modification of the electronic orbits without producing permanent disturbance or ionisation.—W. M. **Davis**: Subsidence rate of reef-encircled islands. The formations in the open Pacific support the view that reef upgrowth occurred on foundations which subside at (1) a slow rate which can be counterbalanced by lagoon aggradation as well as by reef upgrowth, or (2) at a rapid rate which cannot be counterbalanced. Reef upgrowth is slower than coral upgrowth.—H. S. **Vandiver**: Summary of results and proofs concerning Fermat's last theorem.—G. V. **Rainich**: Mass in curved space-time. In the general relativity theory, the electric charge appears as a residue of a field derived from the curvature field; an expression of the type of a residue is obtained for mass in the centro-symmetric case. This mass constant appears to be connected with the complete Riemann tensor, and it seems that, in order to introduce mass, it is necessary to separate space and time.—Aristotle D. **Michal**: Concerning certain solvable equations with functional derivatives.—Joseph Miller **Thomas**: First integrals in the geometry of paths.—Luther Pfahler **Eisenhart**: Einstein's recent theory of gravitation and electricity. Equations which should replace Maxwell's equations are obtained in tensor form.—Oliver R. **Wulf**: Evidence for the existence of activated molecules in a chemical reaction. The heat of reaction when ozone decomposes does not afford sufficient energy for the excitation of the radiation emitted. This radiation agrees closely with the emission spectrum of ozone molecules, suggesting the presence of activated ozone molecules.—John J. **Abel**: Crystalline insulin. An insulin solution (40 rabbit units to the milligram) is taken up in acetic acid, and impurities are precipitated with brucine and removed. Treatment of the clear liquid with pyridine give a crystalline precipitate Larger crystals are obtained by re-crystallisation from disodium hydrogen phosphate. Amounts so small as 0·01 mgm. per kilo of the crystalline substance reduced the blood sugar of rabbits to the convulsive level.

Official Publications Received.

Union of South Africa. Department of Mines and Industries: Geological Survey. Memoir No. 23: The Economic Geology of Sabie and Pilgrims Rest. By W. J. Wybergh. Pp. 124+5 plates. (Pretoria: Government Printing and Stationery Office.) 5s. 6d.

Legislative Assembly, New South Wales. Report of the Director-General of Public Health, New South Wales, for the Year 1924. Pp. v+191. (Sydney: Alfred James Kent.) 8s. 8d.

Ministero dell' Aeronautica: Aviazione civile e traffico aereo. Ufficio presagi. Annuario 1926. Pp. 142. (Roma.)

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 23: Statistics of Teachers Colleges and Normal Schools, 1923–1924. Pp. 60. 10 cents. Bulletin, 1925, No. 35: Review of Educational Legislation, 1923–1924. By William R. Hood. Pp. 22. 5 cents. (Washington, D.C.: Government Printing Office.)

Aeronautical Research Committee. Reports and Memoranda, No. 964 (Ae. 196): The Representation of Aircraft Performance Tests, using Non-Dimensional Variables, with special reference to the Prediction of the Effects of Change of Loading on Performance. By R. S. Capon. (A.4, a Full Scale Work—Aeroplanes general 125—T. 2096 and A.) Pp. 7+2 plates. (London: H.M. Stationery Office.) 4d. net.

Havsforskningsinstitutets Skrift. No. 28: Isarna vintern 1922–23. Referat: Das Meereis im Winter 1922–23. Av Gunnar Granquist. Pp. 121. 30 Fmk. No. 30: Thalassologische Beobachtungen im Alands- und Schärenmeer im Juli 1922 und Juli 1923. Herausgegeben von Rolf Witting und Hans Pettersson. Pp. 89. 7 Fmk. No. 32: Talassologiska vårexpeditionen 1924. Referat: Die thalassologische Terminfahrt im Jahre 1924. Av Risto Jurva. Pp. 27. 4 Fmk. No. 33: Beobachtungen von Strom und Wind an den Leuchtschiffen im Jahre 1923. Von Erik Palmén. Pp. 26. 6 Fmk. No. 34: Regelmässige Beobachtungen von Temperatur und Salzgehalt des Meeres im Jahre 1923. Von Gunnar Granquist. Pp. 64. 10 Fmk. No. 35: Havsforskningsinstitutets verksamhet under år 1924. Redogörelse avgiven av Rolf Witting. Pp. 22. 4 Fmk. No. 36: Dagliga vattenståndsuppgifter 1923. Referat: Tägliche Wasserstandsangaben 1923. Av Henrik Renquist. Pp. 46. 8 Fmk. (Helsingfors: Statsrådets Tryckeri.)

The Indian Forest Records. Entomology Series, Vol. 12, Part 7: Descriptions of new Species of Niponiidae and Cerambycidae from India. By J. C. M. Gardner. Pp. 17+1 plate. (Calcutta: Government of India Central Publication Branch.) 6 annas; 8d.

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 8, No. 6: The Determination of available Phosphoric Acid of Calcareous Soils. Part i: Inapplicability of Dyer's Method to highly Calcareous Soils; Part ii: Extraction of Phosphoric Acid of Calcareous Soils with Salt Solutions; Part iii: Potassium Carbonate Method for Estimation of available Phosphoric Acid of highly Calcareous Soils. By Surendralal Das. Pp. 99–104. (Calcutta: Government of India Central Publication Branch.) 12 annas; 1s. 3d.

Transactions of the Natural History Society of Northumberland, Durham and Newcastle-upon-Tyne. (New Series), Vol. 6, Part 2. Pp. 115–242+lxxxvi+iv. (London: Williams and Norgate, Ltd.) 5s. 6d.

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, 1924–1925. Pp. 18. (London: H.M. Stationery Office.) 2s. 9d. net.

University of California Publications in American Archaeology and Ethnology. Vol. 18, No. 2: Clear Lake Pomo Society. By Edward Winslow Gifford. Pp. 287–390. 1.35 dollars. Vol. 22, No. 1: Californian Anthropometry. By Edward Winslow Gifford. Pp. 217–390+plates 2–53. 2.25 dollars. (Berkeley, Calif.: University of California Press.)

United States Department of Agriculture. Department Bulletin No. 1363: Host Relations of Compsilura concinnata Meigen, an important Tachinid Parasite of the Gipsy Moth and the Brown-Tail Moth. By R. T. Webber and J. V. Schaffner, Jr. Pp. 32. (Washington, D.C.: Government Printing Office.) 5 cents.

University of Washington Publications in Anthropology. Vol. 1, No. 2: The Distribution of Kinship Systems in North America. By Leslie Spier. Pp. 69–88+9 maps. Vol. 1, No. 3: An Analysis of Plains Indian Parfleche Decoration. By Leslie Spier. Pp. 89–112. Vol. 1, No. 4: Klallam Folk Tales. By Erna Gunther. Pp. 113–170. (Seattle, Wash.: University of Washington Press.)

The Institution of Mining and Metallurgy. List of Members (with Topographical Index), Constitution and By-Laws and Royal Charter of Incorporation. March 1926. Pp. 158. (London.)

Reports of the Council and Auditors of the Zoological Society of London for the Year 1925, prepared for the Annual General Meeting to be held on Thursday, April 29th, 1926. Pp. 79. (London.)

Diary of Societies.

SATURDAY, April 17.

North of England Institute of Mining and Mechanical Engineers, at 2.30.—Dr. R. Thiessen: The Contributions made by the Microscopical Study of Coal (Address).—Discussion on Paper by P. S. Lee on Haulage Accidents, and one by S. Burns on Winding Costs: A Plea to the Purchaser of Electric Winding Plant for Withdrawal of Stipulations which are not conducive to Economical Working.

Royal Institution of Great Britain, at 3.—Dr. W. T. Calman: The Shipworm (1).

MONDAY, April 19.

Institution of Post Office Electrical Engineers (at Royal Technical College, Glasgow), at 2.30.—Films: Travelogue of London and Rural Districts, with Special Reference to Telephone and Cable Development.—Creating the Instruments of Speech.

Royal Geographical Society (at Lowther Lodge), at 5.—Dr. Vaughan Cornish. Harmonies of Tone and Colour in Scenery determined by Light and Atmosphere.

British Psychological Society (at London Day Training College), at 6.—A. G. Hughes: Number Games: their Value as Drill in Arithmetic

Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (Annual General Meeting) (in Liverpool University), at 7.—Prof. S. P. Smith: An All-Electric House.

Institution of Electrical Engineers (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.15.

Royal Institute of British Architects, at 8.

Aristotelian Society (at University of London Club), at 8.—Dr. C. D. Broad: Kant's First and Second Analogies of Experience.

Royal Society of Arts, at 8.—C. R. Peers: Ornament in Britain (Cantor Lectures) (1).

Chemical Industry Club.

TUESDAY, April 20.

Royal Statistical Society (at Royal Society of Arts), at 5.15.—H. W. Macrosty: Statistics of British Shipping.

Society of Chemical Industry (Chemical Engineering Group) (jointly with Birmingham Section) (at White Horse Hotel, Birmingham), at 6.30.—W. A. Benton: Measuring and Weighing Apparatus as applied to Chemical Works.—W. Hall-Simmons and F. C. Sutton: Rotameters in Chemical Industry.

Royal Society of Medicine, at 5.30.—General Meeting.

Institute of Marine Engineers, at 6.30.—W. Griffiths: Bearing Metals.

Royal Photographic Society of Great Britain, at 7.—C. Fabry: The Photographic Plate as a Measuring Instrument for Visible and Invisible Radiations (Hurter and Driffield Memorial Lecture).

Institution of Automobile Engineers (at Royal Society of Arts), at 7.30.—H. S. Rowell: Experiments on Laminated Springs.

Royal Anthropological Institute (Indian Section), at 8.30.—L. H. Dudley Buxton: Ethnic Relations in India and the Near East.

Medico-Legal Society (at 11 Chandos Street, W.1), at 8.30.—C. Ainsworth Mitchell: Some Aspects of the New Regulations on Preservatives.

WEDNESDAY, April 21.

Royal Institution of Great Britain, at 5.15.—Prof. J. Barcroft: Organs of Multiple Function: (2) The Spleen.

Royal Meteorological Society, at 5.—Dr J. Glasspoole: The Driest and Wettest Years at Individual Stations in the British Isles, 1868 to 1924.—C. E. P. Brooks: (a) The Meteorological Conditions during the Glaciation of the present Tropics, being some Remarks on the Climatological Basis of Wegener's Theory of Continental Drift; (b) The Variations of Pressure from Month to Month in the Region of the British Isles.

Geological Society of London, at 5.30.—L. R. Cox: *Anthracopupa britannica* sp. nov., a Land Gastropod from the Keele Beds of Northern Worcestershire.—H. P. Lewis: On *Bolopora undosa* gen. et sp. nov.: a Rock-Building Bryozoan with Phosphatised Skeleton from the Basal Arenig Rocks of Ffestiniog (North Wales).—Dr. C. A. Matley: The Geology of the Cayman Islands (British West Indies), and their Relation to the Bartlett Trough.—Sir T. W. Edgeworth David: Exhibition of Lantern-Slides illustrating the proposed new Deep Boring on the Great Barrier Reef, off Cairns (Queensland).

Institution of Electrical Engineers (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—Major E. I. David: Electricity in Mines.

Royal Society of Arts, at 8.—Major-Gen. Sir George McMunn: Some Aspects of the Business Side of an Army.

Institute of Chemistry (London Section).

Society of Glass Technology (Annual General Meeting) (at Sheffield).

THURSDAY, April 22.

Royal Institution of Great Britain, at 5.15.—Prof. O. H. P. Prior: Anglo-Norman Literature: An Introduction.

Institution of Electrical Engineers, at 6.—Sir J. J. Thomson: The Mechanics of the Electric Field (Kelvin Lecture).

British Astronomical Association (West of Scotland Branch) (at Royal Technical College, Glasgow), at 7.30.—Dr. J. K. Fotheringham: Early Astronomical Observations and their Value.

North-East Coast Institution of Engineers and Shipbuilders (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.30.—H. Thomson. Humber Arm Hydro-electric Scheme.

Chemical Society, at 8.—W. C. Reynolds: An Analysis of the Ether. Part II. The Magnetic Fields in Atoms.

C.B.C. Society for Constructive Birth Control and Racial Progress (at Essex Hall, Essex Street, Strand), at 8.15.—Lord Morris and Dr. Marie Stopes: Debate on Birth Control.

Royal Society of Medicine (Urology Section), at 8.30.

Oil and Colour Chemists' Association.

FRIDAY, April 23.

Physical Society of London (at Imperial College of Science and Technology), at 5.—Prof. C. Fabry. The Absorption of Radiation by the Upper Atmosphere (Guthrie Lecture).

Society of Chemical Industry (Manchester Section), at 7.—Sir Arthur Duckham: The Profession of the Chemical Engineer (Lecture).

Institution of Mechanical Engineers (Informal Meeting), at 7.—F. J. Hookham and others: What our Foreign Competitors are Doing.

Royal Photographic Society of Great Britain, at 7.—S. Turner: An Explorer in the New Zealand Alps (Lecture).

Institute of Metals (Swansea Local Section) (at University College, Singleton Park, Swansea), at 7.15.—Annual General Meeting.

Junior Institution of Engineers, at 7.30.—Question and Discussion Evening.

North-East Coast Institution of Engineers and Shipbuilders (at Newcastle-upon-Tyne), at 7.30.—W. S. Burn: High-Powered Oil Engines.

Royal Institution of Great Britain, at 9.—Prof. R. Whiddington The Luminous Discharge through Rare Gases.

SATURDAY, April 24.

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 3.—J. G. Taylor: Coal anc its Banded Constituents.

Royal Institution of Great Britain, at 3.—Dr. W. T. Calman The Shipworm (2).

CONVENTION, ETC.

April 12 to April 27.

International Forestry Exhibition (at Milan).

April 16 to April 20.

International Society of Medical Hydrology (Annual Meeting wil be held in Czecho-Slovakia). (Particulars from Dr. E. P. Poulton, a 36 Devonshire Place, W.1.)

April 17.

Optical Convention (at Imperial College of Science and Technology):—At 10 to 12.—Reading and Discussion of Papers; at 12—Concludin General Meeting.

April 29 to May 5.

World's Forestry Congress (at Rome).

SATURDAY, APRIL 24, 1926.

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The Position of Naval Engineers.

IT was the late Lord Goschen who, forty years ago, remarked in the House of Commons that "discontent in the public service is a great calamity to the country." Curiously enough, he was then referring to the efforts being made to raise the status of engineer officers in the Royal Navy. Were he alive to-day he would have greater cause to utter the warning, for if ever there was a matter calling for inquiry and remedial measures, it is the discontent which has arisen through the treatment of the engineer officers of to-day, and especially those who have been trained at Osborne and at Dartmouth. These are the officers who, instead of electing to remain on the upper deck and to become navigating, torpedo, and gunnery officers, have specialised in engineering duties and are therefore known as lieutenants 'E' and commanders 'E.' Numbering between two and three hundred, these officers have been promised over and over again that by specialising in engineering their position as executive officers should in no way be jeopardised, and that they should be considered eligible for appointments as admiral superintendents of dockyards and similar posts. They were, in fact, to remain on an absolute equality with the navigating, torpedo, and gunnery officers, except that by becoming engineer officers they abandoned the right to command sea-going ships and, of course, fleets. Of these things there is no shadow of doubt whatever. There never was a clearer case of what was promised and intended, and the officers in question have nothing to fear by the fullest publicity.

The discontent to which we refer is the result of the Fleet Order No. 3241 of last November, an Order which will go down to history as one of the most sinister pieces of internal legislation recorded in any of our public services. Meanly conceived, provocatively worded and aggressively promulgated, that Order has created dissatisfaction throughout the engineering world, and the remonstrance uttered by Sir William Ellis at the recent dinner of the Institution of Naval Architects, when two members of the Board of Admiralty were present, is without precedent in the history of naval affairs. This great Institution was founded in 1860, but we believe a search through its index would fail to find any similar reference to any body of officers employed under the Admiralty, much less to a body of officers who come under the Naval Discipline Act. The remonstrance of Sir William Ellis had been preceded earlier in the day by the speech of the Duke of Northumberland, who, as president of the Institution, voiced the opinion of the council on which serve some of our greatest naval architects, shipbuilders, and engineers, and among whom are Admiralty officers.

We have already, in our article of February 6 on "The Status of the Naval Engineer," given a fair and impartial account of the circumstances leading up to the grant of military status to all engineer officers, and we there referred to the deputation which, with Sir William Ellis as its head, waited upon the First Lord, the Right Hon. W. C. Bridgeman, M.P. Mr. Bridgeman's reply unfortunately revealed no spirit of conciliation or sympathy. He practically told the deputation they had no case, there was nothing in the order derogatory to the position of the engineer officers, and that there was no cause for any feeling of injustice. If Mr. Bridgeman really meant what he said, then he could not have taken the trouble to get down to the bottom of things, while if he simply acted as the mouthpiece of the executive officers on the Board, he was wanting in the first attribute of a statesman.

The further action of the deputation is justified in every respect. It immediately published in full the memorandum which had been handed to Mr. Bridgeman; it stated that Mr. Bridgeman's reply was viewed with grave concern, and it said it would take steps to raise the question in Parliament and the public press. Since then a debate has taken place in the House of Commons in which Mr. Bridgeman treated the matter as of little moment and, among other things, said, "I do not think that those who have raised this question are doing any service to the Engineer Officers in the Navy by trying to magnify what I think is a very trifling irritation," so that which every engineer both inside the Admiralty and outside consider a gross injustice, Mr. Bridgeman regards as a "trifling irritation."

The more one knows of the Order the more one is astonished; and how the distinguished men on the Board could have put their names to such a document is inexplicable. The Order, if it meant anything, meant that it took away the special standing granted to engineer officers by the Selborne Scheme and by the Admiralty action in 1915. The granting of military status to engineers in the Navy was welcomed right throughout the land, but to-day, with the echo of the guns still in our ears, the very Admirals who gained their earldoms and their knighthoods and their grants of public money through the successes which in the first place depended on the efficiency of the engineering branch of the Navy, are content to see the engineers again reduced to the inferior position they occupied for so long.

Were all their eulogies of the engineering department so much lip service? Here is one such eulogy: it was written after the Battle of Jutland. "During action the officers and men of that department perform their most important duties without the incentive which the knowledge of the course of the action gives to those on deck. The qualities of discipline and endurance are taxed to the utmost under these conditions, and they were, as always, most fully maintained throughout the operations under review."

During the War, the Engineer-in-Chief was responsible for a personnel exceeding eighty thousand, and yet to-day his department can be treated as if of little account; an Order adversely affecting the whole of his staff can be drawn up without consulting him, and all the guarantees given can be converted into scraps of paper.

To all this there is no answer. The pages of the engineering press and the columns of the *Times* have recorded again and again the protests of the engineers who have served in the Navy and are of the engineering profession, and though there are some three hundred retired flag officers and some six hundred retired captains, none of them come forward to uphold the Admiralty or to explain the need for the deprivation of the engineers of their military status. Could there be any more significant fact? The Order of last November had as its sole object the belittlement of the engineers, and it was known at the time that the want of military status would load the scale against the engineer on every possible occasion.

It would be a slander to say that the Order of November reflects the general attitude of the executive officers of the fleet toward the engineer officers, for there is plenty of evidence to the contrary. If the Board of Admiralty is resolved not to rescind the Order, it will be the duty of the Engineering Institutions to take the matter higher, for clearly the injustice of the whole thing will inevitably foster that discontent which Lord Goschen stated to be "a great calamity to the country."

Egyptology in Victorian Dress.

Descriptive Sociology: or, Groups of Sociological Facts. Classified and Arranged by Herbert Spencer. Division 1, No. 11: Ancient Egyptians, Compiled and Abstracted upon the Plan organised by Herbert Spencer by Prof. Sir W. Flinders Petrie. Issued by Mr. Spencer's Trustees. Pp. iii + 3 Tables + 79. (London: Williams and Norgate, Ltd., 1925.) 25*s.* net.

"IN preparation for *The Principles of Sociology,* requiring as bases of induction large accumulations of data, fitly arranged for comparison, I, in October 1867, commenced by proxy the collection and organisation of facts presented by societies of different types, past and present: being fortunate enough to secure the services of gentlemen competent to carry on the process in the way I wished. Though this classified compilation of materials was entered upon solely to facilitate my own work; yet, after having brought the mode of classification to a satisfactory form, and after having had some of the Tables filled up, I decided to have the undertaking executed with a view to publication: the facts collected and arranged for easy reference and convenient study of their relations being so presented, apart from hypothesis, as to aid all students of Social Science in testing such conclusions as they have drawn and in drawing others."

The quotation is from Herbert Spencer's "Provisional Preface" to the second volume in the series which he began to publish under the general title of "Descriptive Sociology," and the date subscribed to it is 1874. Another volume appeared in the same year, and a third in 1876. Fifty years later Sir Flinders Petrie gives us "Ancient Egyptians," and we learn from his preface that two further volumes are in the press, besides a reprint of one of the earlier volumes. Their ultimate purpose is explained in the passage quoted above. The idea of collecting data from all known civilisations (divided into three groups: "uncivilised societies,"—in which ancient Egypt is included !—"civilised societies, recent or decayed," and "civilised societies, present or still flourishing"), analysing their contents, and evolving generalisations from the results, was a colossal conception even for the Victorian Age, when the limits of knowledge in any one sphere were comparatively small.

To-day, no one man would contemplate such an undertaking as an ideal, still less as a practicable possibility. It is now more than twenty years since Spencer died, and the introductory volumes of material, originally intended "solely to facilitate my own work," are still to be completed. What was to be his own work, "The Principles of Sociology," will never appear. In the days when solidity was as essential in furniture as it was in morals and literature, and when to make a book look as much like an office ledger as possible seemed to give it a guarantee of respectability, a book 19½ in. × 12½ in. may well have been considered fitting. But the publishers can scarcely be forgiven for offering their public, in 1926, a work of archaic form and appearance, modelled on the standards of 1850, which for inconvenience of size makes a ledger look almost like a pocket edition! The cover and arrangement of the letterpress within are in keeping, and give the book so antiquated an appearance that one can only suppose it possible that Mr. Spencer's trustees and their publishers are tied up by testamentary red tape in the matter.

If in such a volume the information is considered to have been arranged "for easy reference and convenient study," what should we have had to expect from the great work of which it is only one of the foundation stones?

Yet if we are relieved at our loss, we have to consider that it was essentially the plan that was wrong—and not the purpose. Much in the paragraph quoted at the beginning of the review is strongly reminiscent of the objects for which the Royal Anthropological Institute now exists. The method which Spencer here originated was the method of modern anthropologists. His aim was essentially scientific—to collect all possible data; without which no conclusions were valid. Only, he proposed to do by himself what we now know cannot be done by one man.

In the collection of his material, however, he accepted the principle of specialisation. The bulk of each volume consists in quotations from trustworthy published works, with references, giving all the facts concerning the Society under discussion which can be grouped under the heading sociological. To these were appended tables (generally three or four) giving an analysis of the chronological development of the main sociological factors.

Sir Flinders Petrie began to prepare the volume under consideration in 1910. But, as he points out in his preface, a great deal of our knowledge of ancient Egypt is—and at that time still more was—not yet published in books, but is inherent in the objects in our museums and in the inscribed and painted walls of the buildings of Egypt. Thus, in addition to the extracts from published works (most of which were made by Miss M. A. Murray), a great deal had to be written up by Petrie himself. In this respect it may be noted that, though the work was begun sixteen years ago and its publication only stopped by the War, he has been conscientious in bringing this additional matter of his own up-to-date, at all events in reporting the results of recent excavations. Although in the opinion of the reviewer Petrie is not prepared to give its due to the documentary evidence—on stone inscriptions and papyri—from the ancient Egyptian civilisation, yet no one could deny that we owe a far greater proportion of our knowledge of its sociology to the objects found in the country; and as it was a rich and powerful civilisation which lasted over thousands of years, the variety of those objects is immense.

This has resulted in the production of a book even more of the nature of an encyclopædia than Mr. Spencer's principles necessitate. It is, in fact, a glorified handbook to Egyptology, very thorough in its intention to cover all the ground, but hopelessly inadequate in detail—as it needs must be—on some of the most interesting points. Thus while Herodotus is quoted to prove that gymnastics were practised in honour of a

Greek hero in Panopolis, the inventor of the system of "sequence-dating" has confined his remarks on pottery to two quarter columns which are largely mutually inclusive. But our quarrel here is not with Petrie, for if the work was to be done no one was better qualified for it than he. Rather, the question is: What is the justification for an encyclopædia of this sort? To the specialist in Egyptology it is waste of labour to turn to it. The matter under any given heading is necessarily so general that he already knows it, and the list of reference books, to which he is sent for greater detail, contains nothing with which he is not familiar. In other words, he would go straight to whichever of these works he requires without thinking of consulting "Descriptive Sociology."

For the layman it is more promising—at first sight. For those who have no particular interest in Egypt it may sometimes be necessary to consult Egyptian practice, mainly in connexion with other facts. They have only to refer to the "Contents" of this book, which gives all the headings and sub-headings in the order in which they occur, and takes the place of an index. They can turn up the main facts on the spot and discover where to find a fuller treatment of the subject when they want it. Unfortunately this has been done far better long ago. Erman's "Life in Ancient Egypt" covers all the ground (frequently, of course, in bare detail) and presents a consistent and readable story, efficiently illustrated, and supplies references and bibliography. It does all this in a volume of convenient size for handling, which was quite recently re-edited by Ranke. It is indeed difficult to see how anybody should buy Sir Flinders Petrie's book unless it be that he is anxious to have a complete series of the "Descriptive Sociology."

It is difficult to review the matter, as such, in a compilation of this kind, more particularly when so much of it consists of extracts from other writers. In spite of a large proportion of works by the author—46 out of 158—in the "List of Books," the references are very fairly distributed, and with, on the whole, a very impartial judgment which frequently leads to the juxtaposition of opposite views. It would be strange if there were not details at which to carp. Perhaps the most glaring fault in the text itself is the small space given to the subject headed "Language and Writing." All that we know about the hieroglyphic and cursive writings, and the literature they express, is summarised by Petrie in a single page, and no mention is made of the great Herakleopolitan literary tradition. Such omission, however, is at the worst an error of judgment. There is one point with which criticism must deal far more sternly. It is an old source of bitter complaint amongst Egyptologists, and in a specialist Egyptological journal we should prefer to pass over it. For there, at least, it does no harm, since we are aware of Sir Flinders' idiosyncrasy in the matter. But to those unacquainted with the literature on the subject his introduction to Egyptian chronology will not only be utterly misleading as to the facts themselves, but also prejudicial to the trustworthiness of other writers.

The form of this introduction, consisting of a short list of periods and dates (headed "Periods of Egyptian History"), is familiar to Egyptologists. In these columns are placed respectively a date, the name of the geological period, or later of the dynasty, and the site on which remains of the period have been found. Passing over, as too technical a point for discussion here, the concatenation of two entirely separate flint finds at Badari and in the Fayum Desert under the single description of "Solutrean" (with a correspondingly high date—11000–9500 for both), we come to the crux of the matter in the subdivision of Dynastic dates, headed respectively "By the Egyptians," "By Berlin 1917," and "Berlin 1900." Thus for the 1st Dynasty we get the equation: By the Egyptians, 5500–5300; By Berlin 1917, 4186; Berlin 1900, 3400. If only one Berlin date were given, it might be possible to assume that Sir Flinders Petrie was holding the dating of the Egyptians up to scorn in the light of modern scientific research! As it is, the only conclusion that the uninitiated can draw is that German scholars are so uncertain of their chronological methods that they alter a single date by nearly a millennium in the course of seventeen years' study; hence no reliance is to be placed in them; and that all this is due to the fact that they will not follow the ancient Egyptians' own account of their chronology (as contained in the Palermo Stone, etc.).

This can only be characterised as a very strange presentment indeed of the facts. In the first place, "Berlin 1900" represents the date generally accepted (with very slight variations) by scholars not only on the Continent, but also in Great Britain and in the United States, with only two exceptions, namely, the authors of the systems detailed in Petrie's other two columns, himself and Dr. Borchardt, who is meant by the column "By Berlin 1917," which is still credited by one or two German scholars, in spite of its recent demolition by Prof. Peet. Thus the date proposed by Eduard Meyer (Berlin 1900) has been generally accepted, with but slight modification, ever since. The phrase "By the Egyptians" is equally misleading, suggesting as it does that the German historians must have disregarded the evidence of Egyptian documents. No suggestion could be more inept, for without those documents it would be impossible to produce any chronology at all. We need not go into the technical points for or against the inclusion of the extra Sothic cycle which is responsible for the difference in dating between Petrie and all other scholars; for it should be clear to all fair-minded persons that unless the rest of the Egyptological world is leagued together to put Petrie in the wrong, regardless of truth, the chances are that the majority is right. We do not, of course, take objection to Sir Flinders Petrie's statement of his own opinions, but to this curious presentation of other people's, more particularly in a book which will by its nature be read (if at all) by the layman, who cannot test the matter, rather than by specialists, who discount what Sir Flinders says on the subject of chronology before the time of the XVIIIth Dynasty.

Timber Pests.

Enemies of Timber: Dry Rot and the Death-Watch Beetle, in which the Origin and Life-History of the two worst Enemies of Timber are given, with a Description of the Damage they cause, and the Methods to be adopted for their Examination By Ernest G. Blake Pp. xvii + 206 + 10 plates. (London: Chapman and Hall, Ltd., 1925.) 12*s.* 6*d.* net.

IN these days when there is grave need of sound technical advice designed to decrease private and national waste, and when it is so desirable that the general public shall acquire confidence in the practical value of technological science, it is regrettable that so unsatisfactory a compilation as the book under review should have been published In the text elementary errors on fundamental matters and details abound, while misleading practical conclusions and unsound advice recur at intervals. A few quotations suffice to justify this condemnation.

"The endogens [monocotyledons] are described as inward growers, because the new tissue is formed annually at the centre of the tree instead of at the outside." "In the hardwoods [dicotyledons] the annual rings are nearly always narrow . . ; the colour of the wood is dark . . .": in the softwoods [conifers] "the annual rings are a good deal wider than in the previous class. . . ."

"Dry rot is caused by the extraction of a portion of the mineral contents by the roots of the fungus." "There are four conditions that are necessary for the successful germination and for the development of the fungus [causing dry rot]; these are darkness . . ."; there is "absolute necessity for the complete stagnation of the air before it [the fungus] can develop to its fullest maturity."

Particularly dangerous as regards its practical results are the misstatement that a fungus causing dry rot "is propagated only by means of spores," and the allegation that fungus-infected wood can be sterilised by "subjecting it to heat . . . in a drying kiln that is raised to . . about 110 Fahr." Of the many species of fungi causing dry rot the author deals only with three, all of them growing outside as well as inside wood; he never even mentions those species the vegetative growth of which is confined to the interior of the wood. Despite of repeatedly terming dry rot a disease, he fails to see that the most economic treatment should be that suited to the particular fungus present, and regardless of expense he prescribes the same costly treatment for all.

The part of the book dealing with the only two species of wood-attacking insects considered, *Anobium punctatum* and *Xestobium tesselatum*, is perhaps the least unsatisfactory; for the author appears to have made free use of the writings of Dr. Gahan and Prof. Maxwell Lefroy, and provides some excellent figures of the two species and their work Yet it is truly remarkable that an author setting out to give practical advice on preservation of wood in buildings should be under the impression, and should actually state, that dangerous attacks by Xestobium are more unseen and stealthy than those of termites and fungi causing dry rot. He appears to be unaware that a joist attacked by 'worm' sustains its load years after its surface shows holes made by these insects, whereas a joist hollowed to a mere shell by termites, or thoroughly rotten with internal decay caused by a species of Lenzites, may show no external sign of injury before it crashes

P. G.

British Universities.

The Yearbook of the Universities of the Empire, 1926. Edited by W. H. Dawson. (Published for the Universities Bureau of the British Empire.) Pp. xii + 792. (London: G. Bell and Sons, Ltd., 1926.) 7*s.* 6*d.* net.

THE "Yearbook" was first published in 1914 as a handy substitute for a collection of the calendars of the universities of the British Empire. According to the preface, the aim of the editor was to collect from the calendars information of general interest and value to members of other universities, to public bodies, and to the public generally. This is a task by no means to be underrated, and we may say at once that it has been admirably carried out. The arrangement of the book is conveniently simple and consistent throughout, so that in a few minutes a working knowledge of it can be obtained.

The volume is intended to be used for reference and can scarcely be said generally to be 'readable' in the ordinary sense; nevertheless, the introductions to the sections dealing with the universities of Great Britain and Ireland, of Canada, of Australia, of South Africa and of India, form interesting summaries of the history of university education in the Empire. Under the heading of each university is collected a vast amount of important and useful information as to the institutions, teachers and degrees, together with some account of inter-university co-operation and what may be called extra-mural work, such as public lectures and extension work.

University education is now an integral part of our national life, and the general public can scarcely fail to find interesting the sketch of the work of the universities of the British Empire and the notes showing the developments during the past year.

The appendices, in our opinion, constitute the most valuable part of the work. The sections on individual universities are undoubtedly a great convenience, but would probably be used most extensively by those who already have access to the calendars. The appendices, however, collate information of the utmost value. It is obviously necessary, for parents and teachers especially, to have a concise guide to the professions and careers for which universities can provide preparation, and in this respect the information may be considered adequate. No less valuable is the section dealing with professional schools and subjects of specialised study in the universities of the United Kingdom. Again, information is collected in the appendices as to matriculation examinations and conditions of admission of students from abroad. This alone should assure that the "Yearbook" is ready of access to parents and students, especially to those residing abroad. We have had considerable experience of overseas students, and are certain that much disappointment and expense would be avoided by them if they had a clear idea before they left home as to what the universities require for the purposes of admission. The "Yearbook" information on the subject is by no means exhaustive, but it at least provides an indication as to how to proceed.

Much could be said in commendation of the other appendices, but it will be sufficient in a short notice to express our opinion that the editor has performed a great service by including information about inter-university scholarships and research grants and about foreign universities, since the practice of migrating to other universities at home and abroad for advanced work has now fortunately become well established.

In dealing with a book of this kind it is not unimportant to note that there are complete indexes of names and of colleges as well as a general index. Looking at the "Yearbook" as a whole, it is difficult to see how the material could have been arranged more effectively. It is extraordinary what interest the editor has managed to infuse into a book which, in the manner of directories, must be dull in places. The work, too, must be regarded as one result of the working out of the great aim of the body for whom it is published—the Universities Bureau of the British Empire—namely, to bring into closer touch with each other the universities of the Empire.

S. J. W.

Histogenesis of Human Endocrine Organs.

The Histology of the more Important Human Endocrine Organs at Various Ages. By Dr. Eugenia R. A. Cooper. (Oxford Medical Publications.) Pp. xiii + 119. (London: Oxford University Press, 1925.) 12s. 6d. net.

In this small volume a praiseworthy attempt is made to record the histological appearances of some of the endocrine organs of the human subject at various ages. The author confines her task to the thyroid, parathyroid, pituitary body, suprarenals, and thymus, though recognising that the latter organ has little claim to be considered an internally secreting gland.

For purposes of comparison of the same organ at different ages constant methods of fixation and staining are necessary, and the author has selected the simplest and most commonly employed. Formal infixation has its advantages when the material to be investigated is not available immediately after death; but exact cytology is impossible, and only the grosser changes in structure can be revealed under these conditions. For this reason the work will be of more interest to the pathologist than to the histologist. Another serious difficulty lies in the determination of what is normal and what is pathological in human material. Some of the observations recorded in the book have been made on subjects, presumably healthy, who have died from accidents, but the bulk of human material obtained from the mortuary is more likely to be pathological. The author is aware of this, and quotes Hammar to the effect that "the thymus gland is never found in the normal condition in persons who have died from disease." But bearing this in mind, a real service is undertaken in the description of glands at different ages as revealed by ordinary methods. A knowledge of microscopic structure at various ages in the human subject can only be obtained by the continuous observation of an abundance of carefully selected material. The author has made a good beginning, and it is to be hoped that she will carry on the work.

The pituitary gland is fully described; but it would be better in future to distinguish between the pars intermedia and pars tuberalis, the histological characters of which are quite distinct in the human pituitary. Some interesting observations are made upon the development of the suprarenals, but the employment of special methods is necessary to arrive at their correct interpretation.

The volume would be improved by the addition of the pancreas and gonads to the list of organs described. The condition of the Islets of Langerhans in pathological conditions requires investigation, but more elaborate methods would have to be undertaken if anything is to be made of the 'a' and 'b' cells of these structures.

The photomicrographs are for the most part well chosen and admirably reproduced; an index and useful bibliography are also furnished.

Our Bookshelf.

The Classification of Flowering Plants. By Dr. Alfred Barton Rendle. Vol. 2: Dictoyledons. Pp. xix + 636. (Cambridge: At the University Press, 1925.) 30*s.* net.

After a somewhat long delay, the second and concluding part of this work has appeared, and may be cordially welcomed. Like the first, it follows the system of Engler, but in a general and not in any very close manner, and with considerable alterations in the system that many will think to be great improvements, especially from the point of view of practical usefulness in the study of systematic botany—the purpose for which the work is chiefly designed.

In a large monographic study, like the great work of Engler and Prantl, one must try to represent as closely as possible what one considers to be the most natural phylogenetic arrangement practical with the knowledge then available But in ordinary practice, with a reader who is not highly skilled in taxonomy, one may almost say that the more nearly phylogenetic the arrangement, the more difficult does it become to use the system for the everyday purpose of determining the approximate relationships of plants more or less casually encountered. A departure from this method is desirable in the case of a book designed for students, and that is provided here with the restoration of the old group of the Monochlamydeæ. To be able to place a plant at once in one of three, rather than in one of two, divisions of dicotyledons is a great simplification of the labour; instead of having to wade through thirty orders, one has at most only seventeen. Each of the three groups thus made is then grouped in a phylogenetic arrangement, the Dialypetalæ, for example, beginning with the Ranales (now so commonly accepted as the most primitive of all) and working up to the Umbelliflorae, the Monochlamydeæ running from the Salicales to the Centrospermæ. Various alterations are also made in the arrangement of the orders and families, as compared with that adopted by Engler, and a great improvement is the splitting of some of Engler's unwieldy orders, *e g.* of his Geraniales into Geraniales and Rutales.

Turning to the details of the book, the accounts of the individual families are clear, full, and concise, and at the end of each is given a most useful reference to the two or three most important publications dealing with that family. Finally, a word of praise must be given to the clearly drawn and well-explained figures and diagrams.

Plant and Animal Improvement: a Textbook for Students of Agriculture. By Prof. Elmer Roberts, in consultation with Prof. Eugene Davenport. Pp. xii + 174 + 5 plates. (Boston, New York and London: Ginn and Co., 1925.) 6*s.* net.

This modest volume stands distinct among a rather considerable number of books on genetics and breeding which the past few years have brought us. Its aim is "To give the student an intelligent view of the processes involved in the improvement of plants and animals." A simple primer, with no pretensions to being anything else, in letter and in spirit a 'practical man's' book, it seeks not to prove but to relate. Simple language, with plenty of attractive illustrations and clear diagrams, will undoubtedly appeal to the agricultural reader who interests himself in science solely because it may forward his practice

Although detail is minimised, the exposition of fundamentals appears in general to have that security which brevity may sometimes endanger The field of the book is naturally limited, but seems wisely chosen. Domestication with the elements of cytology and reproduction in animals and plants make a good introduction. Then come the rudiments of heredity and selection and those interesting theories, like telegony and prepotency, with which the breeder appears almost to be born. An inspiring chapter for the breeder is taken up by the ancestry of domestic animals. At the end is the now inevitable chapter on statistics. This is almost too brief and simple to be safe. But it is not in the brief exposition alone that statistical principles are so presented to the agriculturist as to jeopardise biological soundness. That yield trials should find no adequate place is much to be regretted In scope and standard the book falls below the requirements of a normal university course for agriculturists. It offers, however, very profitable reading for the beginner and will certainly attract the practitioner.

Plant Forms and their Evolution in South Africa. By Prof. J. W. Bews. Pp. viii + 199. (London: Longmans, Green and Co, 1925.) 12*s.* 6*d.* net.

In discussing in detail the growth forms of South African species of plants, Prof. Bews has developed in an inspiring way a conception of their ecological evolution. Starting from the idea that a certain number of plant habitats (such as moist tropical forests, stream sides, and swamps) are likely to have persisted little changed for long periods and at least since Cretaceous times, he points out that these primitive types of habitat are on the whole chiefly populated by primitive types of plants. This conclusion holds whether the plants are judged to be primitive either on their reproductive characters or on their vegetative form. It is, therefore, a corollary of this that, on the whole, the more highly developed types of plants will occur chiefly in the more specialised types of habitat.

The South African flora lends itself very readily to interpretation along these lines. A large element of the flora is assumed to have come from the moist tropical forests to the north, and it is, therefore, not unexpected to find that most of the characteristic endemic forms are xerophytic. Further, if, in line with recent discussions, the tree growth form is regarded as primitive, then it automatically follows that the large number of scrub and grassland species in South Africa are, on the whole, of more recent origin, and the general trend of evolution would thus be towards xerophytic types. Prof. Bews notes that in such sub-tropical areas there is a tendency for a larger number of tropical types to appear as a given succession progresses, and he suggests the possibility of making use of this sequence to obtain some idea of the evolutionary groupings. An interesting observation is credited to General Smuts—that as the South African season develops, the tropical elements become more prominent, to the partial exclusion of the specialised South African types.

Blacks and Pitches. By H. M. Langton. (Oil and Colour Chemistry Monographs.) Pp. xi + 179 + 7 plates. (London: Ernest Benn, Ltd., 1925.) 15*s.* net.

This is one of a series of very useful monographs on oil and colour chemistry. The first five chapters deal with the production and properties of black carbonaceous pigments, followed by three chapters on the uses of such pigments in the paint, printing ink, and rubber industries. The following nine chapters deal with pitches, bituminous materials, and so on, the industrial uses in roofing felts, paving materials, paints, japans, etc., being considered in the concluding three chapters. Chapter xviii. is devoted to the weathering and ageing of bituminous materials.

A very wide range has been covered, and it can scarcely be expected that a full treatment of the subject could be condensed into 170 pages. Nevertheless, the volume is very readable and the author is to be congratulated on having done so much in so little space. The general arrangement of the book is good, the chapters following each other in logical sequence. An effort has been made to scan briefly all recent work on the subject, and for the reader seeking more detailed information the references and bibliography will be found very useful.

The author has, of necessity, drawn largely on American sources of information, and it will be clearly apparent to any reader how little favour the subject of blacks and pitches has found with research chemists in Great Britain.

The Table IX. on p. 39, taken from Bulletin 192 U.S. Dept. of the Interior Bureau of Mines, ought to have been reproduced in full scale, since in its present state it needs a lens to read it. Tables X. and XI. suffer from the same defect, and also Fig. 10. In this diagram the explanatory details to which the numbers refer have been omitted.

Visual Education. By F. N. Freeman and others. Pp. viii + 391. (Chicago: University of Chicago Press; London: Cambridge University Press, 1924.) 3.50 dollars.

Many recent books on juvenile delinquency have suggested that 'the pictures' have an educational influence in the undesirable arts of pilfering and truancy. This book, however, is a comparative study of the value of the moving picture and of other visual and oral methods of presenting the more conventional educational information imparted in schools. It summarises the results of a number of investigations made in the United States with a grant from the Commonwealth Fund. Most of the experiments consisted in teaching the same lesson to parallel classes of children by different methods—the motion picture, the lantern, personal demonstration, and oral presentation—and comparing the subsequent knowledge and achievements of the children.

The results so far obtained are not very conclusive, but suggest that up to the present the chief use of the motion picture is in furnishing an introduction to instruction about moving objects, but even then it should be shown in small lengths. For general purposes, demonstrations and oral lessons, with the accompanying personal emphasis of the teacher, give more satisfactory and lasting results.

Much research is needed, the authors contend, to find all the fields of instruction in which the cinema will be useful, and the form of film best adapted to educational purpose. The interest aroused in this new type of teaching for industrial as well as for scholastic education will undoubtedly ensure that such research will be forthcoming. W. J. G. S.

Left-handedness: a New Interpretation. By Beaufort Sims Parson. Pp. ix + 185. (New York: The Macmillan Co., 1924.) 8*s.* 6*d.* net.

The interest that has long been felt in the subject of left-handedness is testified to by the forty-seven pages of bibliography at the end of this book, and by the number and variety of theories described in the first chapter. Hereditary transmission, visceral distribution, anatomical inequalities, have all been advanced as possible explanations of left-handedness, but Mr. Parson finds none of these completely satisfactory and therefore offers a new and plausible theory of ocular dominance. His tenet, for which he gives experimental proof, is that man has progressed from pure binocular vision, and now has developed unilateral sighting facility which furnishes clearer vision. From this 'one-eyedness,' 'one handedness' (as opposed to ambidexterity) naturally follows, for the hand on the side of the functioning eye is more convenient for aiming. Habit ensures that this same hand is used for the manufacture and use of all instruments.

Mr. Parson suggests that the right, rather than the left, eye and hand have biological ascendancy from natural selection due to the increased chances of survival of those who used their left hands to protect their hearts, while their right hands were controlling their weapons.

Mr. Parson has devised a manuscope—an instrument for determining the dominant eye, and hence the probable handedness He has used it with interesting results with a large group of school children. The theory needs more evidence before it can be accepted, but it is decidedly suggestive and well worthy of future research. W. J. G. S.

Trattato di chimica generale ed applicata all' industria. Per Prof. Dott. Ettore Molinari. Vol 1: *Chimica inorganica* Parte Seconda. Quinta edizione riveduta ed ampliata Pp. viii+681-1351. (Milano: Ulrico Hoepli, 1925) 45 lire.

The publication of five editions of a treatise on chemistry of the magnitude of 'Molinari' within the space of twenty years furnishes irrefutable evidence of the cordiality with which the book has been received by Italian chemists. The present volume follows the same general lines as its predecessors and completes volume 1, dealing with inorganic chemistry. Although the bulk of this second part exhibits no great advance beyond that of the corresponding portion of the fourth edition, descriptions of most recent developments of value have been added. Moreover, a number of entirely new sections are included, the most noteworthy being those on the low-temperature carbonisation of coal, decolorising vegetable carbons, pulverised coal, titanium pigments, and the borax industry of Tuscany. The important subjects of electrolytic soda and cement are accorded even more detailed treatment than formerly.

In general, the statistical data which form such a marked feature of the book are brought up-to-date, but in many cases the prices of products are still qualified by the description 'pre-War.' The numerous figures are mostly well reproduced and the printing is good, the rather smaller type, of which considerable use is made—evidently with the object of reducing the proportions of the volume—being not at all irksome to read. The price is fixed at what in Great Britain and nowadays would be a ridiculously low amount, and any chemist with a knowledge of the Italian language would find the book a profitable investment. T. H. P.

The Professor on the Golf Links: some Sidelights on Golf from Modern Science. By Charles W. Bailey. Pp. 91. (London: Silas Birch, Ltd., n.d.) 2*s*. 6*d*. net.

This book is by the same author as "The Brain and Golf," which was reviewed in these columns (August 23, 1924, p. 271). It consists of a light-hearted report of the casual conversations of some members of a golf club. The chief talker is known as 'The Professor,' whose topics range from the effect of jazz jumpers for men on their interest in colour and relation to women, to psychological types as reflected on the golf course and even in the owners' golf sticks as well. The author aims at linking golf with mental and physical science in order to interest the average golfer and lower his handicap. It is in lighter vein than the preceding volume, but contains much sound psychology embodied in anecdotal form. He describes golf as the safest safety-valve, because in it the unconscious gets an opportunity for expression in a way socially safe and personally satisfying. One would like to know the incidence of psychoneurosis in golfers: Are the irascible people who let off their irascibility on the links thereby rendered comparatively innocuous and able to bear with equanimity the stresses of ordinary life? The author has yet to give us a more subtle analysis of behaviour on the golf links in terms of modern psychology.

Simen, its Heights and Abysses: a Record of Travel and Sport in Abyssinia, with some Account of the Sacred City of Aksum and the Ruins of Gondar. By Major H C Maydon. Pp. 244+12 plates. (London: H. F. and G. Witherby, 1925.) 16*s*. net.

In setting out on the journey which is described in this book, Major Maydon and his companion, Capt. Blain, had as their objective the barrier of mountains which forms the north-western edge of the great Abyssinian plateau. A preliminary journey of reconnaisance in 1922–23 was followed by a second expedition in 1923–24 in quest of the Walia ibex (*Capra Walie*), the home of which is in Simen, although its existence, as the author says, "was a question of uncertainty." From Simen they went on to Addis Ababa and into the Arusi country in search of mountain inyala. Major Maydon's descriptions of the wonderful hill country of Abyssinia, slashed by precipitous ravines and abysses, conveys a vivid impression to the reader, which is enhanced by some excellent photographs; but he seems to have found, with reason, the natives less attractive than their country. The appendices, in addition to descriptions of the Walia ibex and the inyala, and their habits, give information relating to prices and outfit which will be useful to those who may be inspired by the author to follow in his footsteps.

Practical Pharmacognosy. By T. E. Wallis. Pp. x+115. (London: J. and A. Churchill, 1925.) 7*s*. 6*d*. net.

This excellent little book will be of great value to teachers and students requiring an elementary guide to laboratory work in pharmacognosy. The standing of the author, who is lecturer in botany to the Pharmaceutical Society, and the recommendation implied by the contribution of a foreword by Prof. Greenish, are sufficient guarantees of the accuracy of the text, which is arranged in a very clear and practical manner. The ground covered is necessarily familiar, but the chief value of the book lies in the fact that it is essentially a statement of the laboratory work in this subject given at Bloomsbury Square. Part 1 consists of schedules of instructions for the examination of the drugs, each schedule being accompanied by a most useful complement in the form of short notes. Part 2 comprises a description of forty-five medicinal plants and concludes with a scheme for the description of drugs. The book is abundantly illustrated, and special reference must be made to the many skilful line drawings prepared by the author and his wife.

The Pocket Book of British Birds. By Richard Kearton and Howard Bentham. Pp. ix+389. (London, New York, Toronto and Melbourne: Cassell and Co., Ltd., 1925.) 6*s*. net.

Mr. Kearton and Mr. Bentham have produced a pocket guide to British birds. The letterpress consists of a condensed summary of the usual text-book information about each species. The very small reproductions of photographs seem unlikely to be so useful for purposes of identification as the authors suggest.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Fine Structure of the X-ray Absorption Edge in the *K*-Series of Argon and its Possible Interpretation.

As is well known, X-ray absorption phenomena may be characterised in the following manner: In general the absorption decreases with decreasing wave-length of the X-rays. A sudden increase of absorption, however, takes place at some definite wave-lengths ('absorption edges') characteristic for the absorbing element in question. Each of those absorption edges is connected with the removal of an electron from a corresponding sub-group of electrons in the atom. As for the heavier elements there are one sub-group of electrons in the *K*-shell, three in the *L*-shell, five in *M*-shell, we might expect the existence of one *K*-absorption edge, three *L*-edges, five *M*-edges. Such edges have really been found for several elements by different workers.

More accurate measurements, especially of the workers in Siegbahn's laboratory, have brought to light that the wave-lengths of the absorption edges to a rather small amount still depend on the chemical or physical state of the absorbing element. Besides, in some careful investigations it has been shown that the main absorption edge very often is accompanied by one or two other rather faint edges lying immediately in the neighbourhood and usually to the short wave-length side of the main edge. As has been shown by Miss Chamberlain,[1] at any rate part of this 'fine structure' of the absorption edges must be ascribed to the presence of different chemical compounds in the absorbing screen used in the investigations. As in the case of photographic registration, the time of exposure has to be rather long, it is reasonable to assume that an appreciable amount of the absorbing substance may be decomposed during the exposure by the action of the X-rays. We have, however, several reasons for believing that not all of the fine structure of absorption edges hitherto observed can be explained in the above simple way.

In order to obtain some more conclusive data regarding the fine structure of absorption edges, we have investigated the *K*-absorption spectrum of argon. The use of this substance has several important advantages. The well-known Siegbahn vacuum-spectrograph could be filled with the gas. By varying the pressure of the gas the most favourable condition for getting a sharp absorption edge was easily obtained. Complications due to chemical changes of the absorbing substance as observed by Miss Chamberlain are excluded. Besides, we should expect that an eventual fine structure in the case of a mono-atomic gas would afford less difficulties for a theoretical interpretation.

One of the present writers,[2] and independently Wentzel,[3] have suggested the following explanation of the fine structure of X-ray absorption edges. The main edge in the case of the *K*-absorption corresponds to the transition of one *K*-electron just to the outside of the atom; the other edge or edges lying to the short wave-length side of the main edge should correspond to a simultaneous transition of two electrons connected with one single absorption act. If one of these electrons is the *K*-electron and the other an electron of the outmost sub-group, we should expect the order of magnitude of the energy difference of the main edge and the secondary edge to correspond to about 10 volts, which is just the order of magnitude usually found by experiment.

The absorption edge of argon was exposed with gypsum as the analysing crystal. Though several exposures were tried with argon pressures ranging from 3 mm. to 80 mm., no fine structure at all could be detected on the plates, the edge itself being very sharp and prominent. Using the same gypsum as analysing crystal for the elements chlorine and potassium as absorbers, however, in the same time of exposure (from one to six hours) a very good fine structure was easily obtained. The same thing was tried for other regions of the spectrum where we should expect secondary edges connected with a simultaneous transition to the outside of the atom of a *K*-electron and an electron of one of the other sub-groups of the *M*-shell, or a transition of a *K*-electron and an *L*-electron, or of two *K*-electrons. No such edge could be detected, though in our experiments a sudden change of the total absorption of 1 per cent should have been easily detected (the total absorption being 95 per cent. of the intensity of the incident rays). From these experiments we may conclude that absorption processes connected with transitions of more than one electron do not contribute to the absorption of X-rays to any appreciable amount, and that such transitions at any rate cannot explain the occurrence of the fine structure of absorption edges.

We may also assume that the fine structure of absorption edges might correspond to transitions to the different optical orbits available for the electron removed from the inside of the atom by an absorption process.[4] Now in the case of a mono-atomic gas such as argon, the fine structure connected with those optical orbits may be easily estimated. If an electron has been transferred from the *K*-shell of argon to an optical orbit of the same atom, this electron moves in a field of force which to a high approximation must be the same as the field of force of the valency electron in the ordinary potassium atom, the difference in nuclear charge of one unit being compensated by the absence of one *K*-electron. If the same selection rules which are applied in the field of optical spectra and of ordinary X-ray spectra also hold for a transition of an electron from an X-ray orbit to an optical orbit, the only optical orbits which in the present case come into consideration are *p*-orbits, as the orbit of the *K*-electron may be compared with an optical *s*-orbit. The largest energy difference between *p*-orbits, *i.e.* the difference between $2p$ and $3p$, corresponds to about 1·4 volts, which is far too small a difference to be separated in our experiments referred to above.

We therefore repeated the experiments with calcite as the analysing crystal and a very narrow slit (0·025 mm.). We really succeeded in obtaining two different absorption edges at about 0·1 mm apart, separated by a rather sharp black line. Control plates were taken to make sure that the observed structure could not be ascribed to any other cause but the presence of argon in the spectrograph. Measurements of our plates gave for the difference of the observed edges about 1·7 X.U. corresponding to 1·7 volts (with an accuracy of about 20 per cent.). Thus we may state that the difference measured is certainly of the order of magnitude theoretically expected.

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[1] Katherine Chamberlain, NATURE, October 7, 1924; *Phys. Review*, 26, 525 (1925).

[2] D. Coster, *Zeitschrift für Physik*, 25, 83 (1924).

[3] G. Wentzel; see Sommerfeld's book, fourth German edition, p. 326.

[4] An analogous suggestion was made for the first time by Kossel, in his earlier work on the classification of X-ray spectra.

With the accuracy hitherto obtained it is, however, impossible to decide with certainty if this difference really must be ascribed to a $2p$ and a $3p$ orbit (the only other energy difference of the potassium spectrum which might come into consideration as being of about the same magnitude is $1s$-$2p$ corresponding to 1·6 volts). Other eventual edges corresponding to higher p-orbits lie too close together to be separated even with calcite.

Experiments are being started with the X-ray absorption spectrum of neon, for which fine structures are expected corresponding to energy differences in the optical spectrum of sodium. As in this case the separation is expected to be much larger than in the case of argon, we hope to be able to decide some questions which still remained unsettled in our experiments with argon.

D. COSTER.
J. H. VAN DER TUUK

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Spinning Electrons and the Structure of Spectra.

GOUDSMIT and Uhlenbeck have suggested that the structure of multiple lines in spectra can be made much more comprehensible if it is assumed that the electron itself has a magnetic moment of one Bohr magneton ($eh/4\pi mc$) and an angular momentum of one-half unit ($h/4\pi$), which can orient itself in various ways with respect to the normal to the electron orbits Goudsmit and Uhlenbeck point out (*Naturwissenschaften*, Nov 20, 1925) that to obtain such a magnetic moment from the rotation of a Lorentz electron about its axis, there would have to be a peripheral velocity greatly exceeding the speed of light. It can also be easily seen that the magnetic energy with its resulting mass would be much greater than the electrical energy. These difficulties do not seem to be easy to overcome by any small modification of the classical model of the electron. It appears, however, that an entirely different picture of electronic structure, based on the idea of light quanta, is capable of giving a consistent explanation of the energy of the electron, and also of predicting the values of some of the electronic constants

The author has suggested that the energy in light waves consists of corpuscular quanta which are guided by a virtual field, along Poynting's vector or some similar direction. In general, the direction could not be just that of Poynting's vector, for that does not transform as a velocity under the Lorentz transformation. In the particular case where E and H are equal and at right angles, however, as for a wave in free space, a vector of magnitude c along Poynting's vector may be proved to transform as a velocity, so that for this case it can be taken as the velocity vector of the quanta. A defect in such a scheme was the existence of the constitutive energy of the electrons, which presumably is energy in the field, although otherwise the field was not supposed to carry energy. The present suggestion is that the electron's field itself is virtual, and that its energy consists of a quantum, which is permanently attached to it, revolving about it To make this consistent with the radiation theory, the path of the electronic quantum should be determined in the same way as the path of a quantum in a radiation field. This can be done; for if we imagine a virtual field, consisting of an electrical point singularity e, and a magnetic doublet singularity $eh/4\pi mc$, there is a circle in the equatorial plane at every point of which Poynting's vector is tangential to the circle and satisfies the particular conditions given above, so that this orbit can be the path of a quantum The circle has a radius r_0 satisfying the condition that the electric field at this distance, e/r_0^2, should equal in magnitude the magnetic field, $eh/4\pi mcr_0^3$, which gives $r_0 = h/4\pi mc = 1{\cdot}93 \times 10^{-11}$ cm. Evidently at points of this circle the fields are perpendicular to each other, and Poynting's vector is tangential. The picture of the electron is then an energyless field from a point charge and doublet, with the energy and angular momentum located in the quantum travelling with the speed of light in a circle of radius r_0.

We assume the energy of the quantum to be given by the quantum condition for a rotator in its first state, $E = h\nu/2$, where ν is the frequency of rotation. Since the quantum travels with the velocity of light, this frequency is $c/2\pi r_0$. Substituting for r_0, this is $\nu = 2mc^2/h$, giving from the quantum condition $E = h\nu/2 = mc^2$. The mass of this energy is $E/c^2 = m$, so that the quantum carries just the mass of the electron. The angular momentum is equal to mr_0c; again substituting for r_0, this equals $h/4\pi$ Thus we obtain a rational explanation of the half-quantum value of the angular momentum, and of its anomalous ratio to the magnetic moment.

In attempting to work out the dynamics of the paths of quanta, many interesting questions present themselves. It is necessary to consider that there are forces acting on quanta which must operate when the quanta change their direction and hence their momentum The reactions of these forces on atoms may in some cases be the "quantum forces" which the author has suggested for changing the atom from one stationary state to another in a quantum transition. It is hoped that a further study of these forces will provide more definite information about the dynamics of an electron such as has been here suggested.

J. C. SLATER

Jefferson Physical Laboratory,
Harvard University,
March 18.

Mercury Helides.

IN a first note (NATURE, December 13, 1924, p. 861) I announced the synthesis of mercury helide. In a second note (NATURE, March 7, 1925) the empirical formula of the compound was given as HgHe, and afterwards (NATURE, June 20, 1925, p. 947) the formula $HgHe_{10}$ was substituted for the earlier one. Details of the methods and apparatus used for synthesizing the compound were given in a paper communicated to the Royal Society last July. The chief points of interest with which that paper dealt may be conveniently enumerated as follows:

1. The formation of the helide is accompanied by a decrease in the pressure of the helium.

2. The maximum decrease in pressure during any synthesis was never greater than 3·3 per cent. of the initial pressure of 6 mm.

3 At ordinary temperatures the helide possesses stability, but on passing the gas over a red-hot platinum spiral it is completely resolved into its components; and as a result of the decomposition the helium is restored to its original volume and pressure.

4 The compound is neither liquefied nor absorbed by charcoal at the temperature of liquid air.

5. In a quantitative analysis of the helide, the total weight of the mercury obtained was 0·00021079 gm.

6. Experiment proved that the helide is most readily formed when the pressure of the helium approximates 6 mm. of mercury

7. Qualitative experiments made with a Jamin

interferometer having tubes 25 cm. long showed that, as the synthesis progressed, the refractive index of the mixture became somewhat greater than that of the helium alone.

During the past seven or eight months the plans for synthesizing the helide have been modified and the apparatus enlarged. All qualitative experiments made with the new apparatus have clearly indicated the formation of the helide $HgHe_{10}$ and have thus tended to confirm the accuracy of my earlier work. The new apparatus produces a larger quantity of helide, but the maximum percentage found mixed with the helium has never exceeded that obtained in my first experiments.

Using three differently formed synthesizers in series, I have now succeeded in obtaining a second helide of mercury. This also remains gaseous at the temperature of liquid air, and charcoal fails to absorb it.

During the synthesis of the second helide the pressure of the helium was unaffected. Taking the density of helium as 1, that of the mixture of helium and helide, when measured with an Aston microbalance, was found to be 1·150. The helide was decomposed by passing it over a red-hot platinum spiral and the mercury collected. Its weight was 0·0002714 gm. Assuming the formula of the helide to be HgHe, the calculated density of the mixture is 1·148. The close agreement between the measured and calculated values leaves no doubt as to the formula for the helide.

To account for the non-liquefaction of the helides at the temperature of liquid air, I was inclined to regard them as clouds of charged particles. On this point Prof. Soddy has been kind enough to give me his own views. He writes, "I do not think it likely that you have a cloud of solid or liquid particles passing through the liquid air, though it is perhaps a possibility to be borne in mind. . . . My own view is rather that a compound of helium is of a different category from any known chemical compound, as the completed ring of electrons which never act as valency electrons, must be so acting in this case. If so its properties cannot be inferred from those of known gases, and there is therefore no *a priori* reason to expect that it would be condensed by liquid air and charcoal. Its properties must be ascertained *de novo*, and none of them can be inferred from known chemical data." Prof. Soddy regards his views as speculative.

In conclusion, it may be added that experiments made with pure argon yielded results entirely negative. Prof. Soddy has suggested that it would be of interest to repeat the experiments with neon substituted for helium. This I propose doing as soon as I can either purchase or obtain the loan of some 20 c.c. of the pure gas. The presence of helium would obviously be detrimental.

J. J. MANLEY.

Daubeny Laboratory,
Magdalen College, Oxford,
March 25.

Ecotypes of Plants.

IN *Hereditas*, Bd. vi (1925), which has just come to hand, there is an extremely interesting paper by Gote Turesson on "Plant Species in Relation to Habitat and Climate" This author has grown in Sweden upwards of 10,000 cultures of various types and races of certain widely distributed plants, in order to ascertain the precise nature of the forms inhabiting different environments. Particulars are given concerning about fifteen species, with numerous illustrations

It is found that the species exhibit parallel "ecotypes," which it is proposed to designate by the names campestris, arenarius, salinus, subalpinus, and alpinus. These names are by themselves sufficient to indicate the nature of the habitat, and an experienced botanist will be able to imagine the character of the adaptive modification. However, these ecotypes are to be understood to include only hereditarily modified forms, and the immediate effects of the environment are placed in another category. It is shown that the several ecotypes are not produced whenever the conditions seem to call for them. They are sorted out from the genotypes which the plant is able to produce. Thus there are four species (of the genera Melandrium, Ranunculus, Rumex, and Geum) which produce "alpinus" ecotypes in Scandinavia, but not in the Swiss Alps, although the very same species exist in Switzerland. It is as if the plant produced the hand of cards, and the environment played the game. The five parallel sorts of ecotypes correspond with five common types of environments into which suitable varieties might enter and in which they prospered.

The author has done his best to correlate the several ecotypes with names already bestowed by botanists. In this he has not been altogether successful, the numerous available varietal names, based on herbarium specimens, being often not precisely applicable in the sense desired. Thus in *Spiræa ulmaria* the "variety denudata" is present in all three ecotypes studied, and although the type specimen of Presl probably belongs to one of them, the restriction of the name to this ecotype would quite contradict the original intention and general usage. It is therefore proposed that previous names shall be discarded in the type of work represented by the paper, and the ecotype names *campestris*, *arenarius*, etc., substituted, no matter what species is concerned. There are, however, numerous minor biotypes not covered in this way, and the author remarks in reference to *Leontodon autumnalis*: "To those, however, for whom the increase and the naming of 'new' biotypes is a particular pleasure, as well as to other intending bidders, I am willing to offer a couple of hundreds hitherto undescribed in a living and exquisite condition."

At this point it may be possible to question the adequacy of the author's methods. The ecotype names certainly have the very great advantage of being intelligible in a general sense, without further explanation. But ought we to be satisfied with this "general sense"? Mr. Turesson himself brings out very clearly the fact that parallel ecotypes of the same species in different regions may not be just alike. Thus, while the ecotype system is highly illuminating, it should not take the place of definite names accompanied by precise descriptions, and supported by type specimens in the herbaria. Also, it is not clear that the most minute analysis of the various biotypes will not after all furnish the necessary materials for an adequate synthesis. Probably the fault to be found with taxonomists is not connected with the minuteness of their analysis, but with the mechanical way in which much of the work has been done, in the absence of guidance from biological theory. We may even believe that the coming years will see the study of biotypes and phenotypes carried to extremes now undreamed of. The work will represent a fascinating game, out of which will emerge from time to time results of high practical and scientific value.

T. D. A. COCKERELL.

University of Colorado,
Boulder, Colorado,
March 12

The Boskop Skull.

In criticising Pycraft's paper on the Boskop skull, my whole object was to get a fuller consideration of what I believe to be an extremely important early human skull. Opinions will differ so to the restoration of all imperfect human crania. We have seen how greatly anthropologists have differed in the restoration of the Piltdown man, and it is not surprising that there should be differences about the Boskop man.

Pycraft agrees with Haughton in giving the greatest length as 205 mm. Now the calvaria as preserved certainly measures 205 mm., but much of the lower part of the frontal is lost, and though there was certainly no large supra-orbital eminence, there must have been, from the curve of the anterior part of the frontal preserved, at least a small one, and even Pycraft in his restoration shows a small one. By no possibility can the antero-posterior measurement have been less than 208 mm.: it may have been 212 mm. Dart gives it as 210 mm., and this must be very near to the actual measurement.

Pycraft doubts whether any anthropologist would 'restore' the skull as I have done. Perhaps he is right. His own restoration does not differ very greatly from mine. He puts the temporal fragment a little lower than I do, and he has failed to observe the small portion of parietal attached to the temporal. By lowering the temporal fragment he would make the brain still larger than I would. He objects strongly, however, to a brain of 1900 c.c. or more. Elliot Smith, Dart, and Drennen all agree to a brain of 1900 c.c., so that whatever errors I may have made in the restoration I am certainly in as good company as I could desire as to the result.

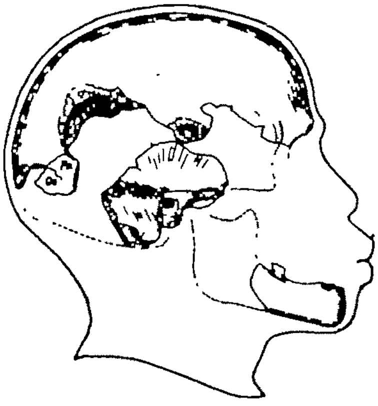

Fig. 1.—Restoration of the Boskop skull, with outline of soft parts as they may have been before the teeth were lost.

With regard to the jaw, concerning which Pycraft has nothing to say in his paper, he makes in his letter (Nature, February 6, p. 196) the following remarkable statement: "All of us who examined this fragment while it was at the British Museum regarded it as of no importance at all!" When I examined the jaw ten years ago, and I have never seen it since, I came to the conclusion, after very careful consideration, that the enlarged socket had held the root of the canine and not the first premolar. I made many drawings of the jaw, which I still have, and even had it X-rayed. Part of the socket, but not all of it, has been eroded by an abscess, but whether this is the socket of the first premolar or of the canine the jaw is still a remarkable one, and it will certainly come as a very great shock to many that a large fragment of the jaw of an extremely ancient and completely fossilised human being—possibly the oldest known 'Neanthropic' type—is regarded by all those who have examined it at the British Museum "as of no importance at all."

Fig. 1 is from a restoration I made ten years ago, and may convince those who are not anthropologists that the skull and even the jaw are of some interest.

R. Broom.

Douglas, S. Africa.

The Stone Age in Ceylon.

In *L'Anthropologie* (Nos. 1 and 2, vol. 36) Dr. Fritz Sarasin discusses in a valuable paper (pp. 75-115) the pros and cons of this question. He concludes that there existed a pre-Veddah population in Ceylon—to which the "Cambridge History of India" does not refer—whose culture was analogous to the Aurignacean of Europe.

Dr. Sarasin, however, makes the arresting statements that it is difficult to imagine how men, possessed of only small stone implements incapable of cutting down trees, could exist in forests so humid and full of leeches as those of the Ceylon mountains, and in which they could not find the necessary subsistence, unless, through climateric oscillations, there occurred steppe periods; and that it seems impossible, with the present climate, for these human stations (which he discusses) to have existed in the forests.

May I recall to Dr. Sarasin's memory the conditions under which the Koeboes of Sumatra exist? These people, perhaps the most primitive on the globe and supposedly the most ancient inhabitants of Sumatra, live in isolated communities in several regions of that island. Their abode from time immemorial has been in the vast, sunless, pathless, tiger- and leech-infested and moisture-laden virgin forests, out of which they rarely emerge of their own accord, but through which their sense of direction is 'uncanny.' They make no clearances, having no implements capable of the work, nor do they cultivate a single comestible. They subsist entirely on the inexhaustible products of the woods, especially on durians, jack-fruits, figs, tubers of sorts, wild honey, and even the putrid carcasses they may discover. From time to time, when successful in killing a rhinoceros or a tapir, they gorge themselves until only the bare bones of their feast remain, alongside which are left no signs of human activity. They live as do the beasts, ever in search of the wherewithal to appease their insatiable appetite. Until the intervention of the Dutch authorities, the Koeboes were hunted by Sumatran 'radjahs' and chiefs for enslavement as if they were really wild animals. The Malay so esteemed them when I made acquaintance with these nomads forty-five years ago. They have no true abiding place; they erect temporary wind-screens with palm leaves and branches, more primitive even than the Australian's humpy. Their weapons, all of wood, are pointed, fire-hardened bamboo spears and the deadly accurate blow-pipe. A few among them now possess knives obtained from the Malays by the curious method of silent exchange. Their dead are thrown into some dense thicket, which is ofttimes set on fire, but the body is generally left for any prowling carnivore. This custom accounts for the rarity of their osseous remains—as probably for that of the bones of the Chelleans and Acheuleans—except of those sedentary few groups, partly 'tamed' and half converted to Moslemism, who practise sepulture.

If these a-lithic nomads had discovered stone artifacture, their handiwork would have strewn the forest floor and been found abundantly in the alluvium of the rivers, without any marked climatic oscillations. Their discarded belongings, which in a few months turn to dust, leave no record of an age-long persistence under their verdant sanctuary. Their life-story, however, affords a highly instructive picture of how generations knowing only wood, of whom no evidence survives, may have succeeded in handing on their race from one millennium to another.

HENRY O. FORBES.

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The Hydrogen Doublet.

IN measuring doublet separations, the Fabry-Perot interferometer can be so adjusted that the fringes of one component fall half-way between those of the other. This eliminates most of the distortion present in other instruments. Using this method, the doublet separations at a pressure of 0·5 mm. and a current density of 0·25 amp. per sq. cm. have been found to be 0·316 ± 0·002 for Hα, 0·329 ± 0·005 for Hβ, and 0·353 ± 0·007 for Hγ. The wave-lengths of each component have also been determined and indicate that $R = 109677{\cdot}70 \pm 0{\cdot}04$, with the use of Sommerfeld's formula.

The doublet separations, however, do not fit Sommerfeld's simple theory with the ordinary principle of choice. They can be explained by assuming that the forbidden components for which $\Delta k = 0$ are present, increase in intensity with an increase in current, and are polarised with the electric vector parallel to the current. These components have always been found in the work on He⁺, so that they would naturally be expected in hydrogen. The presence in Hα of the component designated by Sommerfeld as IIc, will reduce the theoretical separation to the observed value, while the presence of Ib will not affect it very much. The polarisation of IIc will produce a smaller doublet separation in the light from the side of the tube than in that from the end. This is found to be the case when the current is heavy enough partly to orient the atoms. The corresponding polarisation of the light from the side is found also at current densities in the neighbourhood of 1·5 amp. per sq. cm. The increase in intensity of these components with an increase in current will produce a greater relative increase in the short wave-length component than in the other. This is found experimentally to be the case.

The intensities predicted by Kramers, upon the assumption of a disturbing field, are much too small to explain the observations if fields small enough to be compatible with the observed width of the lines are used. The results tend to support the suggestions of Uhlenbeck and Goudsmit (NATURE, February 20, p. 264), which in effect replace the principle of choice for azimuthal quantum numbers with the one for inner quantum numbers.

WILLIAM V. HOUSTON,
National Research Fellow.

Norman Bridge Laboratory,
Pasadena, California, March 13.

Domestic Heating.

LETTERS to NATURE have to be short, so every word should carry its full significance. I said in my letter in the issue of March 6 that the peculiar value in glowing coal fires "is either absent or very weak in radiation from anthracite stoves or gas and electric fires." To a careful reader it would be obvious that I had tried the effects of radiation from a gas fire Prof. Hill (April 3, p. 487) is incorrect in his assumption that I would have got "equally good effects from a *glowing* gas fire." I did *not* get equally good effects from a glowing gas fire On the contrary, I got markedly inferior effects. Even the best form of gas fire is positively irritating rather than healing to surfaces exposed to it.

Of course, I allow that the bright light of a good electric lamp has some slight beneficial effect, and is better than nothing. Prof. Hill quotes its effect on the iguana. Human physiology, however, is very different from that of an iguana, and however useful evidence may be from animals, first-hand evidence from a sensitive human subject is much more valuable.

Prof. Hill speaks of the coal fire polluting the atmosphere and screening off the sunshine. May I ask him to examine the returns of the tonnage used in domestic fires and note how small it is compared with the millions of tons used by commercial fires? I am entirely with him in claiming that electricity and gas should be used in all factories and for cooking and heating water. Moreover, before condemning the domestic coal fire, Prof Hill should take into consideration the possibility of its improvement (which I urged upon our Government in 1914) The valuable domestic qualities of coal could be retained and the smokiness and economic loss of by-products be eliminated by the use of partial coking at low temperature.

MARIE C STOPES.

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The Oxidation of Ammonia.

L. ANDRUSSOW (*Ber.* 59, 458, 1926) has suggested a scheme of reaction for the oxidation of ammonia in which nitroxyl, NOH, is an intermediate product. The scheme put forward by Andrussow, together with many others, were derived by the present writer some years ago when engaged in experimental work on ammonia oxidation, but none of these has been published. It seems desirable, however, to point out that the scheme put forward by Andrussow suffers from the defect that nitroxyl, NOH, if formed as an intermediate product, might be expected to break down to a considerable extent into nitrous oxide, a substance which, so far as the writer is aware, has never been detected among the products of the oxidation of ammonia. A more likely intermediate product would be nitrohydroxylamic acid, which is known to break down with formation of nitric oxide It is suggested that the oxidation may occur in the following stages, each reaction in which is bimolecular or unimolecular:

(i) $NH_3 + O_2 = NH_3O_2$.
(ii) $2NH_3O_2 = 2NH_3(OH)_2$.
(iii) $2NH_2(OH)_2 = N_2H_2(OH)_2 + 2H_2O$
(iv) $N_2H_2(OH)_2 + O_2 = N_2H_2O_3 + H_2O$
(v) $N_2H_2O_3 = 2NO + H_2O$

The writer had intended to make further experiments on the mechanism of the oxidation of ammonia but has not been able to carry these out. He therefore puts forward the above hypothesis as an alternative to that of Andrussow, since it does not seem open to the objection mentioned above.

J. R. PARTINGTON

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What We Know.

LET this, from Meredith, be my reply to the electrician in my composite friend Sir Oliver Lodge (NATURE, March 27, p. 453).

O sir, the truth, the truth! is't in the skies
Or in the grass or in this heart of ours?
But O the truth, the truth! the many eyes
That look on it! the diverse things they see,
According to their thirst for fruit or flowers!
Pass on. it is the truth seek we.

HENRY E. ARMSTRONG.

Odours and the Sense of Smell.

By Dr. J. H. KENNETH.

FROM year to year the number and extent of specialised investigations of the organs and sense of smell and of odorous substances is steadily increasing. There are few treatises which deal with the subject in a comprehensive manner, and none which could be termed exhaustive. The reasons for this deficiency in scientific literature are many, the main reason being the difficulty of combining, except by means of a symposium, expert knowledge of each of the many different subjects which coalesce in the science of smell. Boyle's "Exercitationes" (1672), Cloquet's "Osphrésiologie" (1821), Zwaardemaker's "Physiologie des Geruchs" (1895), and "L'Odorat" (1925), the presidential address to Section A of the British Association (1898), by Prof. Ayrton; Haycraft on "The Sense of Smell" (1900), Henning's "Der Geruch" (1916), the "Essai d'olfactique physiologique," by Heyninx (1919), and "Smell, Taste, and Allied Senses in the Vertebrates," by G. H. Parker (1922), are some of the outstanding efforts towards an integration of the heterogeneous elements composing the science of smell. This co-ordination of special knowledge comprised in the science of smell (olfactology, *osphrésiologie, Geruchslehre*) in its widest interpretation may conveniently be termed 'osmics' (*l'osmique, osmica, Osmik*).

The subject may be divided into three main and interdependent aspects or foci; morphological, psychophysiological, and physico-chemical. In addition there would be included all the numerous applications engendered by the science in its different aspects.

The morphological division, again, may be divided into two parts—one dealing with the structure and development of the peripheral and central olfactory apparatus (osphrenes), and the other with the structure of odorous apparatus (osmenes), both in health and disease. There are many anatomical, histological, and embryological data available; for example, accounts of the olfactory mucous membrane of the frog, the olfactory nerve of the goose, the absence of olfactory pigment in albinos, hippocampal abnormalities in epileptics, scent organs of butterflies, and the odorous gland of the chamois, to mention some at random. All these many isolated observations require some sorting out and co-ordination, not merely in order to facilitate knowledge of morphological work already done, but also to stimulate and direct further research and integration of knowledge. Even the comparative histology of the olfactory mucous membrane, or that of the vomero-nasal organ, has yet to be completed, let alone the comparative morphology of osphrenes and osmenes as a whole. Consideration is also due to the connexions between the olfactory apparatus and other parts of the body, such as endocrines and the sexual apparatus. Osmics thus provides a most extensive field of research, not only for the individual morphologist, but for team work.

While noses have an interest all of their own, it is their performances which make a wider and more intensive appeal. From the mysteries of good and evil as represented by fragrances and stinks, to the examination of the psycho-galvanic response to the action of hydrogen sulphide and amyl acetate on the lipoids in the hairs of the olfactory cells, is a far cry, a cry dimly perceived by the osmic as well as by the cosmic philosopher. The general study of reactions to olfactory stimuli is not easily systematised, partly owing to the prolonged courtship between physiology and psychology. However, a discussion of some of the problems requiring elaboration will indicate the scope of the physiological and psychological aspects.

To begin with, the nature of olfactory stimulation is not yet satisfactorily understood. The general opinion would favour the theory that it is induced by some form of solution of the odorous molecule (odorivector, *Geruchstrager*). The minimum number of such odoriferous molecules necessary to produce an olfactory sensation is estimated by Prof. Zwaardemaker to be 20×10^8 in one nasal fossa. The intensity of the sensation would appear to depend on the number of molecules impinging on the olfactory mucous membrane, while the quality of the sensation depends on the molecular structure of the odorivector. According to Heyninx, the quality of the olfactory sensation depends on the wave-length of the molecular vibration, only such wave-lengths being sensed as lie between 0·35μ and 0·20μ. He does not record the inference that this theory would account for the greater liminal range in many animals. Further, following conclusions by Parks which have been quoted by Chwolson, the molecules would form a layer of 0·13μ in thickness on the surface of the olfactory membrane. Their vibration would be transmitted to the olfactory hairs and cells Heyninx suggests that the olfactory pigment functions so as to provide something like resonance. It has occurred to the writer that such 'resonance' may be due to one of the primary functions of the pigment being possibly that of a protective screen against overstimulation of structures in the corium of the olfactory mucous membrane, by ultra-violet activity.

A considerable amount of work has been done by various observers, chiefly by Zwaardemaker, on the measurement of olfactory acuity (olfactometry) in health and disease. Observations on the senses of the Todas, by Rivers, and experiments on Javanese and Europeans, by Grijns, adumbrate a more extensive investigation of olfactory acuity in the different races of mankind. More quantitative data than are now available on the olfactory acuity of animals are also desirable. Of interest here, too, is the measurement of simple reaction time, which has been carried out by Buccola, Moldenhauer, Vaschide, and requires amplification and comparison with association time. Crude stop-watch experiments tend to show that in a given individual the time required for smell-word association does not seem to differ from that for word-word association; but there is a difference which requires demonstration by more exact methods of experimentation.

Another interesting field for research is the investigation of olfactory reflexes and odour preferences. There are inborn and acquired likes and dislikes, which form a kind of olfactory syndrome or diathesis characteristic of the individual. Owing to fluctuations in the affective judgment of odours due to changes in metabolic conditions, it would seem probable that an olfactory diathesis would have some diagnostic value, especially if linked with an examination of colour preferences.

Although the history of perfumery gives much information with regard to odour preferences among different peoples, experiments on a large scale are desirable in order to correlate affective judgments with other factors, such as pigmentation, endocrine balance, etc. Quite an appreciable amount of work has been done on the question of smell and sex, but there is room for further investigation. The problem of preferences is intimately related to the examination of olfactory associations. When dealing with familiar odours, the percentage of failures to form ascertainable associations is relatively small, according to recent (1924) experiments only about 15 per cent. The fact that olfactory associations are very largely formed unawares, makes their investigation of some practical importance, especially when linked up with olfactory associations occasionally occurring in dreams. An odour constitutes a more effective characterisation of persons, objects, and places than a verbal description, and the absence of a direct vocabulary of olfactory sensations raises difficulties. However, the images called up by odours are so vivid that there would seem to be a case for their occasional employment in the practice of psycho-analysis. Another suggestion is to employ odours to induce certain ‘ moods ’ for therapeutic purposes, and perhaps, in time, the ancient use of burned feathers may develop into a system of osmotherapy based on a wide knowledge of olfactory reactions.

Olfactory fatigue has not been mentioned, nor the problem of a classification of odours, nor methods of educating the sense of smell, nor a tithe of the many problems awaiting co-ordination and further research by the physiologist and psychologist. The plethora of osmics is further indicated by the multitude of problems arising from a consideration of the nature of odorous substances (osmyls).

The relations between odour and chemical constitution, emphasised by Haycraft, Cohn, Durrans, and others, by the increasing number of investigations carried out in the industry of perfumery and flavouring materials, has been further extended by recent research on phenomena connected with odorous particles. Tyndall’s discovery of the absorption of radiant heat has led to the examination of infra-red absorption by Grijns and the ultra-violet absorption bands by Heyninx, and of correlated phenomena. It is not yet possible to draw satisfactory physiological conclusions from these investigations (the interpretations of which are open to criticism), but it can be stated that potential molecular energy may act on the olfactory cells. Zwaardemaker and Hogewind (1920) have pointed out that in homologous series there is an increase in diamagnetism exactly proportional to the number of atoms in the molecule. However, even Zwaardemaker (1925) is obliged to acknowledge that the precise nature of the olfactory stimulus has not yet been satisfactorily explained, but that “ il y a de nombreuses perspectives pleines de promesses, qui pourront être dévoilées en continuant la recherche physique.” Even this most cursory and incomplete account of some of the innumerable problems tends to show the need for co-ordination and direction of research, not merely in the interests of pure science, but also on account of the numerous applications in everyday life, in industry, and in medicine. There is ample justification for the organisation of the science of smell as a whole, in order that existing data may be integrated and further research may be organised and directed.

The Geological Age of the Earth.[1]

IN delivering the twenty-seventh Robert Boyle lecture last year, Prof. J. Joly returned to his attack on the higher estimates of geological time which have been based on the lead-ratios of uranium-bearing minerals. He favours an estimate of 160 to 240 millions of years for the period that has elapsed since the Archæan, and refers to the lead-ratios of certain thorium minerals and to the sodium method of arriving at the age of the oceans as providing confirmatory evidence. It can, I think, be shown that in both cases the data used are misleading, and that the results from both methods can be readily interpreted to support the very estimates to which Prof. Joly considers they are opposed.

On the assumption of uniformitarianism, the salinity of the ocean points to an age of about 80 to 100 million years. The amount of sodium in the oceans has been determined with sufficient accuracy to justify the method, but this cannot be said of the annual increment of sodium brought down to the sea by the rivers. Denudational statistics show that for all the open drainage areas of the world, the total amount of sodium removed in solution is more than 2·1 per cent of the material mechanically and chemically removed from the lands. On the other hand, the rocks actually exposed to denudation contain on an average only 1·3 per cent. of sodium. Thus it appears that the rocks would have to lose more sodium than they had ever contained in order to supply the amounts alleged to have been added annually to the oceans.

Four partial and independent explanations of this remarkable discrepancy can be suggested. (*a*) To a slight extent the discrepancy is mitigated by the fact that part of the material liberated by denudation remains on the lands and is largely left out of account in the above calculations. (*b*) Many of the analyses of river-waters for sodium have probably been inaccurate, for unless extraordinary precautions had been taken to overcome the difficulties inherent in such analyses the results would usually be too high. (*c*) It is also probable that part of the sodium carried by the rivers is cyclic, and the invariable presence of chlorine in river-waters supports this contention. The amount of chlorine in igneous and other rocks is hopelessly inadequate to provide the quantities found in rivers. Volcanic and other juvenile sources have doubtless served to supply most of the chlorine now accumulated in the oceans, but analyses of rain-water show that volcanic sources cannot be of appreciable importance at the present day. The high relief of the existing lands provides the necessary head for a vigorous circulation of groundwaters. This is an important factor in chemical denudation, and is likely to be responsible for part of the mysterious sodium chloride that finds its way into the rivers. (*d*) Another geologically unusual source of sodium supply is found in the easily eroded glacial deposits with which wide areas are now covered.

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[1] Oxford University Press, 1926, pp. 18. 1s.

Neither of the factors (*c*) and (*d*) can have been operative throughout geological time, and if it be claimed that they suffice to explain away the discrepancy, then it is only at the cost of admitting that present rates of supply are, for the same reasons, abnormally high.

This raises for discussion the fundamental assumption of uniformity of rate. In recent years the assumption has been widely criticised on the following grounds, all converging to show that present rates of denudation are far higher than those that have prevailed during the average conditions of geological time. (*a*) The continents are now more elevated and the lands more extensive than they have generally been, since we are now near the close, or just emerging from, a period of great mountain building and uplift (*b*) In the past denudation must have repeatedly fallen to an almost negligible value during long periods of quiet peneplanation, and underground waters which are now relatively vigorous must then have become sluggish and relatively ineffective. (*c*) At least since Cambrian times the greater part of the existing lands have, on balance, received sediments rather than supplied them, whereas at present enormous areas are undergoing rapid denudation. (*d*) The presence of widespread glacial deposits facilitates rapid local denudation. (*e*) Finally, human activities have increased the rate by the removal of forests; the tilling of soils; excavations for transport and other purposes; and the addition to the atmosphere of unnatural quantities of acid gases.

A number of geologists have suggested that present rates may easily be from five to fifteen times as high as the average rate for geological time. Moreover, since river analyses for sodium are open to grave suspicion, and the geochemistry of chlorine is still far from being understood, the real income of the oceans in sodium may be less than a third of the amount alleged to be income, which amount is probably partly fictitious, partly capital restored to circulation. It is not unreasonable to combine these sources of underlying error, and to conclude that the age of the oceans may well be twenty times the 80 or 100 million years commonly assigned to it. At least it is certain that the sodium method cannot at present be considered as making any serious contribution to the problem. On its merits the method can be interpreted as pointing to too high an age, and this is a distinct advantage, since it becomes possible, in a way not hitherto allowed for, to admit the probability that the oceans were originally salt, and that additional supplies have since been furnished to them at intervals by juvenile or magmatic waters.

Turning next to the vexed question of the accumulation of lead in thorium minerals, there is no difficulty in demonstrating that the lead-ratios of such minerals are far from leading to concordant or trustworthy results. Thorium minerals of the same geological age give lead-ratios that vary widely among themselves, generally in the direction of lower values than those afforded by uranium minerals. As a type example of this discrepancy, Prof. Joly takes a pitchblende and a thorite from Ceylon. He says, "whereas the uranium-lead ratio indicated 512 millions of years, the thorium-lead ratio gave 130 millions of years." The actual data for these minerals and other analysed thorites from Ceylon are as follows:

Ref No.	Minerals from Ceylon	Percentages of			Lead-ratios Pb/(U+0·37 Th)	Millions of years
		U.	Th	Pb		
1	Pitchblende	71·40	7·86	4·75	0·066	436
2	Thorite	4·57	62·8	1·28	0·046	304
3	Thorite	3·50	59·2	0·78	0·030	198
4	Thorite	1·62	54·4	0·36	0·017	112
5	Thorite	1·88	65·4	1·71	0·065	429

1. Colonial Reports, Misc No 37, Ceylon Cd. 3190, 1906.
2 and 3 Colonial Reports, Misc No 87, Ceylon Cd 7175, 1914
4 Soddy and Hyman *Trans Chem Soc*, vol. 105, p 1404, 1914
5. Colonial Reports, Misc No 74, Ceylon Cd 5390, 1910.

The ages calculated from Nos. 1 and 4 are lower than those obtained by Prof. Joly because of the adoption of more recent values for the half-periods of uranium and thorium. There is clearly no reason whatsoever for picking out the minimum result given by No. 4 as being in any way more correct than that of the still richer thorium mineral No. 5. The latter gives a ratio practically identical with that of the pitchblende; and when the analyses of the associated thorianites are examined they are found to give ratios varying from 0·048 to 0·075, the average of fourteen ratios being 0·063. The conclusion drawn by Prof. Joly from his comparison of the pitchblende and the thorite No. 4 is based on very limited evidence and is seen to be quite unjustified in the light of the remaining evidence.

The variability of the lead-ratios of thorium minerals suggests that the latter tend to lose lead by the solvent action of percolating waters; and further, that thorium-lead is extracted in preference to uranium-lead. If the lead generated within a uranium mineral forms a highly insoluble uranate, then it is not likely to be easily removed. The lead generated from thorium, however, cannot form a thorate, and within a mineral it is probably present as a comparatively soluble oxide or silicate. Thus there are chemical reasons why one isotope of lead should generally be left while the other is liable to be taken. Atomic weight evidence adds consistent support to this new hypothesis, and for the first time a workable explanation of the long-puzzling discrepancies between uranium and thorium minerals is provided.

If this hypothesis be correct, then the higher lead-ratios of thorium minerals are, like the higher helium-ratios, most likely to approach the true index to age. Thorite No. 5 from Ceylon is likely to give a much more accurate result than No. 4, and, admitting this, there remains no convincing reason for supposing that uranium may have disintegrated more rapidly in the past than we observe it to do to-day. The evidence from pleochroic haloes cannot be accepted as pointing to a declining rate of activity of uranium through geological time, because the part played by the actinium series of elements has not yet been taken into consideration Thorium haloes reveal no variation of radius with age, thus proving in the most conclusive way possible that the rate of disintegration of thorium has not varied appreciably in the past. Since the lead-ratios of some thorium minerals are of the same order as those of uranium minerals of the same geological age, it follows equally that the rate of disintegration of uranium must have remained practically constant. It is quite possible that the ages indicated by the lead-ratios of uranium minerals may be a few per cent. too high, but the evidence is overwhelming against Prof. Joly's contention that they may be so much as four times too high. In the state of our existing knowledge and using the most probable modern data, we may safely say that the age of an unaltered primary mineral is given to a first approximation in millions of years by the formula $6600\ \mathrm{Pb}/(\mathrm{U}+0{\cdot}37\ \mathrm{Th})$. With Prof. Joly's conclusion we shall all agree: "Kelvin's well-known limitation '20 to 40 millions of years' is gone for ever."

ARTHUR HOLMES.

Fuel Research.[1]

FROM time to time the Fuel Research Board, under the chairmanship of Sir Richard Thelfall, and with Dr. C. H. Lander as director, issues technical reports which have received individual notice in NATURE. It has recently issued a general report on its activities, and this is of great interest, because the whole range of the work engaged upon is traversed, and the progress along the lines laid down at the outset can be gauged therefrom. It is fitting to recall the circumstances of the initiation and development of the Board as recorded in the report.

The decision to establish a Board of Fuel Research was taken on February 6, 1917, presumably because the grave difficulties of that time were found to be accentuated by the inadequacy and want of balance in resources of fuels of different types in Great Britain. It was deemed prudent to embark on an intensified scientific study with the resources of the State so as to diminish, if possible, these difficulties and along two main lines of inquiry. The first was to make a physical and chemical survey of the coal seams of Great Britain and a study of the fundamentals of coal. The second line was to make an effort to meet one of the most clamant needs of the times—a supply of liquid fuel home-produced—and simultaneously to provide a smokeless fuel for domestic and other purposes.

Doubtless with the idea that some result of immediate practical value might thereby be obtained, the second of these lines was given precedence, and for this purpose the Fuel Research Station was erected at Greenwich, where the late Sir George Beilby—the first director, and one might almost say the founder—was able to put to a critical test ideas on smokeless fuel production which he had held for many years. This extensive experimental station, which is elaborately equipped for the handling and treatment of fuels by various processes of industrial importance, is described with plans and illustrations in the report now issued.

The report gives an account of the work done there on carbonisation at low temperatures. It must be confessed that the early hopes placed in coal carbonisation at low temperatures have not yet been realised at Greenwich, but let no one conclude that the effort has been in vain. The difficulties are as much economic as technical. The intensive study of carbonisation at low temperatures, which has been a world movement, has clarified our notions on the carbonisation process in general, and the publication of authentic results has equipped with technical data those attacking the problems to-day immeasurably better than the pioneers of twenty years ago. At the Research Station high hopes are now placed in the use of a suitable vertical retort of metal which has been in operation for some time, but patience will be necessary before assessing its commercial applicability.

Apart from war-time necessities, the return of peace is only serving to emphasise the importance of coal carbonisation, which is very generally regarded as a possible means of increasing the value of coal by exploiting all its potentialities—both thermal and chemical. In order that no obstacle shall prevent the merits of any low-temperature process wherever discovered from receiving recognition, the Fuel Research Station is now empowered to test and report on processes without fee. This service already rendered in two cases (NATURE, February 14, 1925, p. 246, and November 14, 1925, p. 728) is of great public value, for the lack of such impartial tests has led to the dissemination of exaggerated ideas and hopes.

The other main line of work contemplated at the start of the Fuel Research Board was the chemical and physical survey of the coal resources of Great Britain. Now, although much information is in the possession of some consumers as to the relative properties of coals of different origin, there is still a great need for published data of the right kind and extent. It is significant that the only published systematic tests of British gas-making coals are to be found in German technical literature. The tendency of fuel technology is towards increasing refinement of method, and this implies increasing discrimination in the choice of raw material. This tendency is well exemplified by the selection which has to be made in coals for carbonisation in the continuous vertical gas retort. The methods, such as grinding and blending of coals, which are now under experiment and discussion for the production of smokeless domestic fuel, will certainly involve a closer technical control, and therefore a more precise knowledge of the original coals. Such a control may well extend to the composition and character of the ash, which is not without influence on the processes of carbonisation and gasification, and on the behaviour in the boiler furnace. The task of such a survey is a great and protracted one, and eminently suitable for the broad shoulders of a State department. A useful and necessary preliminary step has been to arrange a convention of analytical procedure so that results shall be comparable wherever obtained, and this is already well in hand through the Sampling and Analysis Committee of the Board, which includes members well qualified to speak on such matters. The survey, to be satisfactory, needs to be made with reference to geological and mining conditions, and hence a considerable amount of decentralisation has been found advisable. Local committees of coal owners and others have been established in those areas where the Survey is already in operation.

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[1] Department of Scientific and Industrial Research. Report of the Fuel Research Board for the period ended 31st December 1924; with Report of the Director of Fuel Research. Pp. vi+78+8 plates. (London: H.M. Stationery Office, 1925.) 1s. 6d. net.

The Fuel Research Board was called upon to render an important service in its early years, namely, to advise the Government of the day on the action to be taken in re-establishing the standards for the sale of gas, which had been suspended during the War. It was able, however, to avail itself of the comprehensive experimental study of the efficiency of different grades of gas in use, which had been carried out by the Joint Committee of the Institution of Gas Engineers and the University of Leeds. The recommendations it was finally able to make to the Board of Trade were embodied in the Gas Regulation Act of 1920, establishing the "therm" system of charging, which will undoubtedly in time be regarded as a landmark in the history of fuel industries in Great Britain. It has already had a great influence on the outlook of the British gas industry. The process of "steaming" the charge of vertical retorts came into prominence during the War years as a means of expanding the output of existing gas works plant, and led to much discussion in the gas industry. Eventually the Joint Committee mentioned above investigated the claims made for this process in a series of tests at Uddingston, which showed the uses and limitations of steaming. The Fuel Research Board has since then not only confirmed but also added to these results by the carbonisation with steaming of a variety of coals from different areas—a material contribution to the survey of carbonising coals. Work on the water-gas process has also been carried out at the Fuel Research Station.

The utilisation of fuel in domestic grates is so commonplace a matter that many will learn with surprise that until recently little precise scientific information was available, and some ideas popularly held are fallacious. Much of our quantitative knowledge is based on the experimental work initiated in 1912 by the Manchester Air Pollution Board and carried on under its auspices for ten years—latterly with financial assistance from the Department of Scientific and Industrial Research. In 1922 the work was taken over by the Fuel Research Board, and the reports already issued have thrown much light on this important question.

Peat, steam-raising problems, internal combustion engines, alcohol, oil fuel, have all been the subjects of investigations by the Board. There is scarcely a branch of fuel utilisation which has not received some attention; and, indeed, a good idea of the "present state of the art" and the problems awaiting solution may be gained from a perusal of this report. The field of work is so wide that it is impossible for the research staff even of a national board to cover it in more than a fractional measure. It is gratifying to observe recognition of this in the allocation of financial assistance by the Board to independent workers in the universities and other centres of experiment. H. J. HODSMAN.

Obituary.

DR. W. E. HAWORTH.

DR. WALLACE ELLWOOD HAWORTH, who, as a result of a collision between the motor cycle he was riding and a motor car, sustained fatal injuries at Salisbury, Southern Rhodesia, and died on March 13, furnished an example of a man who, possessing naturally a scientific bent, was able to devote himself wholly to scientific pursuits only somewhat late in life. He was sixty years of age at the time of his death and held the post of a Milner Research Fellow in entomology of the London School of Hygiene and Tropical Medicine, having, in accordance with the arrangement made between the School and the Government of Southern Rhodesia, been sent out to work in collaboration with Dr. G. R. Ross, who is engaged upon an inquiry into the etiology of blackwater fever. Dr. Haworth was responsible for the collection and identification of mosquitoes, and was gathering data showing how the distribution of anophelines coincided with the presence of cases of blackwater.

Dr. Haworth, who was born in New Zealand, had always been interested in zoology, a subject to which he devoted himself when at Canterbury College, Christchurch, from 1882 until 1885. He commenced the study of medicine at the University of Edinburgh in 1886, graduated M.B., Ch.B. in 1892, and then turned his attention to public health, taking his B.Sc. in that subject in 1893. In the same year he was appointed examining officer for ships at Leith during an outbreak of cholera on the Continent. After two voyages to India as a ship's surgeon, he settled in private practice in Southern Rhodesia and was there from 1896 until 1917. Throughout this period his interest in zoology was maintained and he was, to use his own words, constantly observing the life-histories of various insect pests.

From 1917 until 1919, Haworth was on active service with the Rhodesian Native Regiment in Nyasaland, German East Africa, and Portuguese East Africa, and thereafter was employed temporarily in Government service, holding the posts of M.O.H. Tanga, acting director of the Bacteriological Laboratory, Dar-es-Salaam, and Medical Officer of Health at Lindi. Both at Tanga and Lindi his duties included those of Port Health Officer. It was especially at Dar-es-Salaam that he made his interesting and important researches on the breeding of mosquitoes in the tops of coconut palms. The results of his investigations were embodied in a carefully written paper which appeared in the *Transactions of the Royal Society of Tropical Medicine and Hygiene* in October 1924. It is noteworthy that, despite his age, Dr. Haworth himself scaled coconut palms during the course of his observations. These have been the subject of some criticism, but are admittedly of a pioneer nature and were the means of bringing three new species of Aëdes to light.

Dr. Haworth returned to Great Britain in 1924 and then, full of energy and enthusiasm, took a course on systematic entomology under Prof. Ashworth. Thereafter, as has been recorded, he received an appointment at the London School of Hygiene and Tropical Medicine. During the few months he was in Salisbury he worked with ardour at his special subject, made arrangements for extensive mosquito surveys, and collected a large amount of material. His tragic and untimely death has robbed the School of a zealous and well-trained research worker, and is greatly deplored by all who knew him.

Mr. A. R. McCulloch.

By the death of Allan Riverstone McCulloch, which took place at Honolulu on September 1, 1925, systematic ichthyology lost one of its foremost exponents. He was born at Sydney, New South Wales, on June 20, 1885, and at the early age of thirteen he commenced work at the Australian Museum, Sydney, as an unpaid assistant. Even in those early days young McCulloch was distinguished by his enthusiasm, his ability, and his determination to succeed. Assisted and encouraged by Mr. Edgar R. Waite, then in charge of the vertebrate section of the Australian Museum, he made rapid progress both in the study of zoology and in drawing, and when, in 1906, Waite became Curator of the Canterbury Museum, New Zealand, McCulloch succeeded him, though he was then not quite twenty-one years old. By that time he had definitely resolved to devote himself to the study of fishes, and that became his life-work, though he was skilled in all branches of zoology, and was a recognised authority on decapod crustacea.

Exceedingly versatile, McCulloch was never satisfied with the second best, and became an expert photographer and kinematographer, an accomplished artist and musician, and a delightful lecturer. Although not of robust physique he was active and full of courage, and had made several adventurous trips to the Great Barrier Reef and various Pacific Islands. In 1922, in company with Captain Frank Hurley, he traversed part of Papua, and returned with many valuable specimens and a wealth of observations on the natives and the animals of the island.

At the time of his death, McCulloch was on long leave granted him by the Trustees of the Australian Museum in the hope that his bodily and mental vigour would be restored. He left Australia to attend the Pan-Pacific Fisheries Conference at Honolulu, and, with his accustomed ardour, he took a leading part in the work; but he overworked himself and paid the penalty of enthusiasm in his chosen field of research.

When McCulloch died at the early age of forty years, he left behind a record of accomplishment rarely equalled in the full span of a human life. His work was marked by thoroughness and accuracy. Largely as a result of his numerous contributions, the taxonomy of Australian fishes has been placed on a secure foundation. Most of his work appeared in the *Records of the Australian Museum* or in the official publications of other State Museums in Australia. His most important work, which embodied the results of many years' toil and research, was his "Check List of the Fishes and Fish-like Animals of New South Wales," published by the Royal Zoological Society of New South Wales (*Australian Zoologist*, vol. 1, 1919, pp. 217-227; vol. 2, 1921, pp. 24-68; 1922, pp. 86-130). This fine piece of work was in 1922 issued separately as "Australian Zoological Handbook, No. 1," and forms an enduring monument to the industry and ability of the author.

McCulloch had a most pleasing personality, and was ever ready to assist his colleagues. Many scientific workers, both in Australia and abroad, owed much to his helpful advice and criticism.

C. A.

Mr. E. K. Jordan.

Eric Knight Jordan, one of the most active and promising among the younger geologists of America, was killed in an automobile accident on March 10. Born in San Francisco on September 27, 1903, the son of David Starr Jordan and Jessie Knight Jordan, he had shown in early boyhood unusual interest in scientific research. Before he entered the university he had made a collection and prepared a manual of the molluscs of California. This MSS., still unpublished, contains much original work, especially on the chitons and the minute snails, Odostomia. His study of the molluscan fauna of Trinidad Head (Calif.) was written when he was fifteen years old, and was published by the U.S. National Museum.

Graduating from Stanford in 1923, with geology as his major subject and zoology as a minor, Jordan made in 1924, under the auspices of Cornell University, a large collection of fishes from Hawaii. Under the direction of the California Academy of Sciences, he took part in a biological and geological survey of the middle portion of Lower California. The reports on the last two expeditions are still unpublished.

A unique combination of heredity and environment made Eric Jordan a perfect specimen of young manhood. Handsome, vigorous, earnest, with a love for his chosen field of science which might be said to approach genius, he was heir also to the personal charm which has endeared his parents to numberless Stanford men and women. But a short month before his death he was married to an accomplished class-mate of his, Elizabeth Roper. The scientific world can but tender its respectful sympathy to one of its masters, so tragically bereaved, and mourn for so fair a promise, never to be fulfilled.

Albert Guérard.

We regret to announce the following deaths:

Dr. S. M. Barton, professor of pure mathematics in the University of the South, and a charter member and past president of the Tennessee Academy of Sciences, on January 5, aged sixty-six years.

Prof. L. G. Gouy, of the University of Lyons, distinguished for his contributions to the theory of the propagation of spherical waves, the velocity of light and Brownian movements, on January 27, aged seventy-two years.

Prof. W. J. Lewis, F.R.S., senior Fellow of Oriel College, Oxford, and professor of mineralogy in the University of Cambridge, on April 16, aged seventy-nine years.

Dr. Carlo de Marchésetti, honorary director of the Museo Civico de Storia Naturale and director of the botanic garden, Trieste, on April 2.

Mr. H. Kirke Swann, author of a number of important ornithological works, including a "Monograph of British Accipitres," now in course of publication, on April 14.

News and Views.

ON April 14 Sir James G. Frazer, O.M., was officially invested by M. de Fleurian at the French Embassy in London with the most distinguished title of Commandeur de la Légion d'Honneur, which had recently been conferred on him by the French Government. This rank in the Legion of Honour is, we believe, the highest which is conferred upon a private individual, and is a fitting recognition of one who for many years has held an outstanding position in the field of thought and scientific investigation. It is a little more than a year ago that Sir James Frazer's contributions to the study of the development of human consciousness as manifested in the religious beliefs and social organisation of primitive and early man received the signal recognition of the Order of Merit. This testimony to his pre-eminence among scientific workers in Great Britain is now supplemented by an honour which will serve to remind his fellow-countrymen, should such reminder be needed, that his reputation stands equally high on the Continent, and that his lectures in France and translations of his works have made the name of the author of "The Golden Bough" almost equally familiar on both sides of the Channel. We offer Sir James Frazer our sincere congratulations on this latest honour.

IN our issue of November 21, p. 758, in commenting upon the recent very successful visit of Sir Ernest Rutherford to the capital cities of Australia, we expressed a desire to know whether the Australian universities which arranged this visit meditated plans for making such invitations at regular intervals. A correspondent informs us that in 1922, at the Australian Universities' Conference in Melbourne, Prof. Darnley Naylor, of Adelaide, suggested that Prof. John Mackail, the well-known classical scholar, should be invited to deliver lectures in certain of the cities in 1923. The interest taken by the public in these lectures led to the appointment in the University of Melbourne of a small body, known as the Overseas Lecturers' Committee, to make arrangements each year, in consultation with the sister universities, for the visit of a distinguished authority from overseas. No restrictions as to subject were laid down. In 1924 Prof. John Adams accepted an invitation, and his addresses on educational theory and practice were greatly appreciated. Last year Sir Ernest Rutherford visited nearly all the States. The lectures are usually given late in August or in September, and a lecturer is able to return to England a few weeks after the commencement of the Michaelmas term. Unfortunately, Australia cannot offer the financial inducements which attract many British leaders to the United States on similar missions. Moreover, the physical strain of a tour extending from Perth to Brisbane may be considerable. But perhaps the exceedingly hearty appreciation of Australian universities and public audiences, and the sense of most valuable work accomplished in forming "a real net-work of thought and action among British universities," may serve to make it easy for Australia each year to obtain the services of an outstanding scholar from the mother country.

AT the present time the changing of generating stations into substations is one which interests electrical engineers. The working, therefore, of the new substations at Ilford is being watched by all those interested in supply. The authorities at Ilford were informed by the Electricity Commissioners so far back as 1920 that no further extensions of their generating plant would be permitted. If they required extra current they would have to take it from a neighbouring generating station. At that time the only suitable station which could supply them was at West Ham, and it is from this station that the supply for the substations at Ilford is obtained. In the future, it is probable that West Ham itself will be a substation, as it is not on the list of the 'selected stations.' This, however, will not affect the supply. These substations, especially when fully automatic, will want regular inspection by a competent staff. Although automatic devices can be looked after by a much smaller staff, yet they must be highly technical. The rapid growth of the supply when the price is reduced will increase the demand for technical inspectors, and we do not think that electricians need fear loss of work or loss of status. The introduction of machinery greatly increases the output, but it does not decrease the number of workers required. One of the substations at Ilford only operates when the load reaches a certain value. Automatic switches actuated by relays then start a rotary converter. Another substation is simply a kiosk built of steel containing high-tension switches which operate a transformer. The rapid extension of fully automatic machinery in substations, both for electric power supply and in telephony, will probably soon be accelerated.

FOR his Friday evening discourse at the Royal Institution, delivered on April 16, Dr. A. W. Hill took as his title "The Quest for Economic Plants." The quest for spices, drugs and herbs has caused men from the days of the remote past to wander far and wide. In Dr. Hill's opinion the available evidence points to South America as the original home of the banana, coconut, and of the ground nut, and possibly of the oil palm, but when and how they were first transported is and will ever be something of a mystery. Turning to the more recent history of plant introductions, the ill-fated voyage of the *Bounty* may first claim attention. This voyage, undertaken in 1787–1789 for the purpose of conveying the bread fruit—Artocarpus—from the South Sea Islands to the West Indies, is of interest not only because of the mutiny and from the fact that David Nelson, a Kew gardener, was appointed by Sir Joseph Banks to look after the plants, but also because a plan of the ship showing the arrangement for the storing and packing of the pots of plants is given. This may be regarded as the first definite attempt in historic times at plant introduction, on a large scale, of an economic product from one part of the world to another.

THE invention by Nathaniel Bagshaw Ward, examiner to the Society of Apothecaries from 1836 until 1854, of Wardian cases, which are in effect miniature green-houses, made possible the introduction of tea from China to India in 1848 by Robert Fortune, curator of the Chelsea Physic Garden. This was followed by the introduction of Cinchona, the source of quinine, from the Andes of northern South America to Kew by Sir Clements Markham in 1861, and thence to India; and by the introduction of Para rubber, *Hevea brasiliensis*, in 1876, by Sir Henry Wickham and others from Brazil through Kew to the East. The quest for economic plants has since assumed a new aspect. It is now very largely one of finding plants resistant to the diseases which everywhere are manifest, such as the Panama disease of bananas, the withertip of limes, the leaf disease of Para rubber which is causing so much trouble in South America, and so on There are also modern problems of great complexity relating to the yield of latex from Para rubber, the improvement in type of the oil palm and genetical work in connexion with cotton, rice, sugar and bananas, besides problems relating to soil and climatic conditions which tend to keep alive the romance of economic botany.

THE report of the Council of the Linen Industry Research Association for the year ended September 30, 1925, was presented to the members, on March 23, at a meeting at the Research Institute, at Lambeg, close to Belfast. The Association has been six years in existence, under the direction of Dr. J. Vargas Eyre, who has been most successful in discovering the problems and meeting the needs of the industry—so much so, that those who at the beginning had little use for science are now not merely warm admirers of the work the staff has done for the industry, but persuaded that such a Research Institute is an indispensable accessory. Success is due to the fact that the director has kept practical requirements always to the fore. Commencing with the seed, a large amount has now been raised (more than a ton from a single seed of Russian origin he selected fifteen years ago), which is calculated to yield a plant of even growth, affording a flax of superior quality. The development of the seed has been most carefully studied, not forgetting its value as a source of oil. The retting process has been so thoroughly investigated that a "controlled process" appears to be well within sight. The preparation of flax for spinning has been a subject of the most searching inquiry, and there would seem to be promise of no slight simplification of spinning operations. The very difficult problems of bleaching and dyeing have also received much attention, with a view to diminishing the excessive loss in weight and alterations which affect dyeing properties.

THESE are but some of the co-ordinated activities of the research staff of the Linen Industry Research Association, which has loyally co-operated to a common purpose, with unusual regard of a practical end. The example set should be of no slight value. It is matter for congratulation, that the Council is able to report that the efforts to finance the Association for a second period of five years have, to a large extent, been successful. Congratulations are due to the chairman, Mr. J. G. Crawford, upon the work he and his Council have done in promoting the introduction of the scientific spirit into their industry. It is age-old and at a critical stage but courageous and clearly marked out for a new and invigorated life of usefulness and prosperity. The feature of the meeting at Lambeg was a most feeling account given by Dr. Eyre of his stewardship To his and the Council's great regret, he is severing his connexion with the Institute. The Association, therefore, is in need of a suitable successor. The post is one of no slight difficulty, as a man is required who has not only sufficient knowledge to have feeling for chemical, botanical, physical and engineering problems, but is also practical in outlook and gifted with tact and organising ability.

THE explorations in Derbyshire caves carried out by Mr. E. C. R. Armstrong, under the auspices of a joint committee of the British Association and the Royal Anthropological Institute during the last two or three years, have produced, and may be expected to continue to produce, important evidence bearing upon the extent and epoch of early man's occupation of the northern Derbyshire area. What may prove an important addition to our knowledge of the archæology of the Peak district, should subsequent investigation confirm and extend present conclusions, has been made by a discovery in a previously unknown cave in the Manifold Valley The cave was found by the Rev. G. H. Wilson of Bakewell, a well-known local archæologist. According to a statement in the *Times* of April 15 he has found in a stalagmite matrix which lies below limestone boulders at the end of the cave a skull and skeletal remains of the rare pleistocene lynx *Felis borealis*. Remains of wolf, polecat, small ox, red deer and reindeer were also found in a lower chamber of the cave. Beneath the stratum containing reindeer was a layer of charcoal, which Mr. Wilson believes to point to the presence of man.

THE April issue of the *Fortnightly Review* contains an article by Mr. Lancelot Lawton entitled "The Coal Report: No Solution." The title is interesting because it would seem to imply that Mr. Lawton thought that the Royal Commission would be able to find a solution for the difficulties of the industry. If that really was his belief, it need only be said that his optimism was not shared by any one familiar with the position of the industry, because it has long been evident to those acquainted with the facts that the solution must come from within the industry itself, and can be reached only slowly by hard work, sacrifices, and an earnest determination to co-operate for the welfare of the industry on the part of all concerned therein. Few will agree with Mr. Lawton "that the Coal Commission has been a lamentable waste of time and an altogether needless proceeding"; the Coal Commission has done admirable service in putting together the facts of the industry clearly and authoritatively, so that all interested can make themselves definitely acquainted therewith, and that there is no longer any excuse for the public ignorance that prevails as to many of the conditions under which coal mining is carried on. The Coal Commission's report shows unmistakably that the trouble with the British coal industry is that the coal costs too much when it reaches the consumer. If Mr. Lawton had grasped this fact, he would scarcely have put forward the solution of the difficulty, which he finds in low temperature carbonisation! It is obvious to any one, even without expert knowledge, that the use which the consumer makes of the coal after he has received it is no remedy for the fact that the cost of British coal to him is too high.

SIR WILLIAM BRAGG is to deliver three lectures at the Royal Institution on April 29, May 6 and 13, at 5.15 P.M., on "The Imperfect Crystallisation of Common Things." Whereas some solid bodies are single crystals, and some are not crystalline at all, a large number consist of aggregates of small crystals, and their properties are dependent both upon the nature of the crystals and the nature of their aggregation. In metals that have been drawn, rolled, or worked in any way, the crystals tend to orientate in special directions, and a large amount of work has been done in recent years on the connexion between these peculiarities of crystalline arrangement, the treatment to which the metal has been subjected, and the consequent changes in physical properties. So also in natural structures, such as wool, cotton, and other fibres, in animal growths such as spines, bones, and teeth, there are peculiarities in the arrangement of their minute crystalline contents, which are often associated with the manner of their growth. The methods of X-ray analysis have been lately applied to the study of such cases, and a new field has been opened up which may well prove to be of great importance in the study of the properties of all rigid structures, both natural and artificial. Sir William Bragg's three lectures will deal with the methods which have been employed in this field, and examples will be given of the results already achieved.

PROF. H. NAGAOKA has now occupied the chair of physics in the Tokyo Imperial University for close on thirty years. In 1921 a committee of his friends and former students undertook the compilation of a volume of original papers in celebration of the twenty-fifth anniversary of his appointment (Tokyo: Publishing Committee of the Nagaoka Anniversary Volume, Tokyo Imperial University, 1925). This has recently been published, and seven hundred and fifty copies have been distributed to physicists and institutions all over the world. The delay is mainly attributable to the great earthquake of 1923, in which at least one of the contributors lost his life. It is a handsome volume of more than four hundred pages, including some forty papers relating to a great variety of problems in physics, mathematics, meteorology and astronomy. The very wide field covered precludes any attempt to review the subject-matter; at the same time it is an appropriate reminder of the remarkable range of Prof. Nagaoka's own interests and researches. The committee is to be congratulated on the production of a notable *Festschrift*.

THE issue of the *Journal of the British Science Guild* for March contains some valuable suggestions for the method of procedure at conferences called to settle important questions on which action by the State is necessary or desirable. The Ministry concerned should first constitute an agenda committee, on which each interest should be represented, to draw up a statement of the points at issue. This should be circulated to each of the interested parties, and each is to make a preliminary reply to all the points at issue. The preliminary replies are to be circulated to all the parties, which are then to send in final replies to replace the preliminary ones. The Ministry then collates statements and replies and shows the points of agreement, if such exist, and the real differences. The actual conference is then constituted by the Minister to discuss the issues as summarised and to make recommendations. This procedure is so scientific and orderly that it might with advantage be adopted at all conferences whether under the auspices of the State or not, and much time and temper saved.

THE Report of the Clifton College Scientific Society, for the years 1924–25, is a record of much useful work and many-sided activities on the part of its members. The weather report for the two years under review is summarised by means of three interesting graphs in which the records are compared with those for the period 1881–1915. Among the natural history notes mention must be made of the record of a nesting Great Grey Shrike, which is of special interest in view of Coward's remarks on this species, in his "Birds of the British Isles." The exact locality is, wisely, not mentioned, though doubtless adequate account of it has been preserved in the School records. As is usually the case with school societies, the Lepidoptera command the larger share of attention among the insect groups, but we are glad to note the plea made that other orders of insects should not be neglected. A start has been made with the Coleoptera, and this excellent example will doubtless be extended to other groups. We cordially endorse the advice given to members of this Society—to study the living insect and its habits, and to collect as sparingly as possible. This is in the best traditions of the naturalist and of the very essence of field work. The members of the Society who are interested in entomology may be advised to explore the possibilities of the Bristol Museum as an aid to the classification of their captures.

WE have received the first number of a new quarterly publication entitled *Health and Empire*, the official journal of the British Social Hygiene Council (London: Constable and Co., Ltd., 10*s*. per annum). The subject-matter consists of editorial comments, articles, reviews of books, summaries of official publications, and notes on the Council's activities. Among the articles, Prof. Cyril Burt writes on the "Contribution of Psychology to Social Hygiene." He has much to say on sex delinquency, and his conclusions are hopeful for the future. He believes that many of the amorous adventures of youth of either sex in civilised life are attributable, not solely to the sex instinct, but also in part to the hunting instinct: the youth prowling after the girl, the girl promenading after an attractive youth, are simply stalking each other, because the streets of the modern city provide no other animal to chase. Much misbehaviour, too, is really based upon the so-called maternal or protective instinct. Prostitution, he believes, will slowly vanish, just as the organised robberies, fighting, and duelling of former times have been mastered. "The main force of the sexual instinct will in the near future be controlled, ennobled and refined." Altogether, a critical and illuminating article! Prof. Percy Nunn contributes an article on the "Influence of Education and Tradition in Social Hygiene," in which he indicts science-teaching in schools. "In our secondary schools for boys, 'science' means scarcely anything beyond physics and chemistry. . . . My conviction is, and has long been, that progress towards national enlightenment in social hygiene must remain slow and disappointing until we rectify these grave defects in our school programmes. We must seek, through genuine, if simple, biological teaching in the elementary and even more in the secondary schools, to correct the orientation of the national mind." Other articles are by Mr. C. J. Bond and Dr. L. Findlay.

Major J. Hall-Edwards, a pioneer worker in X-ray therapy whose name is widely known, has been elected an honorary member by the council of the British Medical Association in recognition of his services to medicine.

Prof. E. G. Coker, University College, London, has been awarded the Louis Edward Levy Medal of the Franklin Institute, Philadelphia, for his paper on "Photo-Elasticity" appearing in the March 1925 issue of the *Journal of the Franklin Institute*. The medal was "founded for the recognition of papers contributed to the Journal of the Institute, descriptive of the author's researches in physical science or of his engineering achievements, which have added largely to the sum of knowledge or aided greatly the well-being of mankind."

Dr. W. E. Gye has been awarded the Walker Prize of 100*l*. of the Royal College of Surgeons of England in recognition of his work in advancing the knowledge of the pathology and therapeutics of cancer during the past five years. The Committee appointed to advise the council of the College in the matter stated that the work suggests "new and hopeful lines of attack upon the problem of the cause of malignant disease."

The following have been elected to honorary membership of the American Museum of Natural History, New York City: Captain J. B. L. Noel, in appreciation of his valuable contributions to the science of geography through his explorations in the Himalayas, and especially in his remarkable ascent of Mount Everest; Kunwar Dillipat Shah Rai Bahadur, for the generous assistance which he extended to the Faunthorpe-Vernay Expedition, which has been so successful in securing for the American Museum of Natural History splendid examples of the Plains animals of India

The Museum of Practical Geology, Jermyn Street, London, S.W.1, is now open to the public at the following times: Week days (except Saturdays), 10 A.M. to 6 P.M.; Saturdays, 10 A.M. to 9.30 P.M.; Sundays, 2.30 P.M. to 6 P.M. The Library will be open from 10 A.M. to 5 P.M. on week days.

The *Transactions of the Faraday Society*, which have hitherto appeared three times a year, will in future be published bi-monthly in order to expedite the publication of papers. In addition to the six bi-monthly parts, reports of two general discussions will be published annually, one in the spring and one in the autumn. The new arrangement begins with Vol 22, 1926. The Publication Committee of the Society will be glad to consider papers on any branch of pure or applied physical chemistry, and under the new arrangement rapid publication will be ensured. Communications should be addressed to the Secretary and Editor, 90 Great Russell Street, London, W.C.1.

A general discussion on "Explosive Reactions in Gaseous Media" is being organised by the Faraday Society to take place on Thursday, May 13, at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W 1 The proceedings will be divided into two sessions The first, from 2.30 to 6.30, will deal with the subject generally, and Prof H. B. Dixon will preside. An introductory survey will be given by Dr. W. E. Garner, and papers initiating discussion will be presented by Prof. Dixon, Prof. W. T. David, Dr. S. W. Saunders, Dr. R. V. Wheeler, Prof. W. A. Bone, and Dr. C. Campbell. The second session, 7.45 to 10, will deal with explosive reactions considered in reference to internal combustion engines. Sir Dugald Clerk will preside, and he will give an introductory survey, being followed by Prof. David and Mr. H. T. Tizard. A dinner will be held between the sessions at the St. Ermin's Hotel. A full programme can be obtained from Mr. F. S. Spiers, 90 Great Russell Street, London, W.C.1.

The Geodetic Survey of Canada and the United States Coast and Geodetic Survey have recently completed a joint circuit of 1860 miles of triangulation in Eastern Canada and New England The 1300 miles in Canada extends from the international frontier south of Montreal along the St. Lawrence to Anticosti Island, then round the Gaspé Peninsula and the coast of New Brunswick to the head of the Bay of Fundy. There begins the 560 miles of the American net which extends via Albany northward to the point on the frontier south of Montreal. The circuit closed with an error of only 42 feet, which averages about one-quarter of an inch per mile.

The United States Department of Agriculture Library has just issued No. 11 of its Bibliographical Contributions, in the form of a list of manuscript bibliographies and indexes in the Department, including serial mimeographed lists of current literature. The bibliographies are classified by subject, 202 entries being divided under 35 headings, and a comprehensive index with cross-references is of valuable assistance in tracing items in greater detail The entry relating to each bibliography is descriptive, indicating its source of origin and giving a brief account of the ground covered by the material catalogued. The list has been made as comprehensive as possible, the assistance of the librarian and chief clerks of the various bureaux having been secured to attain this end.

Messrs J and A Churchill will publish at an early date a translation, by Dr. E. Fyleman, of Dr. B. Waeser's "The Atmospheric Nitrogen Industry," "The Chemistry of the Proteins," by Dr Dorothy Jordan Lloyd, and an addition to the "Recent Advances" series, entitled "Recent Advances in Biochemistry," by Dr. J. Pryde.

The Cambridge University Press will shortly publish Vol. 2 of Prof F. O Bower's "The Ferns (Filicales)," dealing with the Eusporangiatae and other relatively primitive ferns. The same house will also issue "The Southern New Hebrides: an Ethnological Record," by C. B Humphreys, being an account of the ethnological conditions of the five southern islands of the New Hebrides: Tanna, Anaiteum, Futuna, Aniwa, and Eromanga

Applications are invited for the following appointments, on or before the date mentioned.—A scientific officer for research in connexion with electrical ignition appliances—The Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (May 15, quoting Ref. A 81) Civilian education officers (Grade IV), Royal Air Force, with good academic and practical qualifications for teaching engineering subjects —The Secretary, Air Ministry, Adastral House, Kingsway, W.C.2 A research physicist, with experience in research—The Director, Research Laboratories of the General Electric Co., Ltd., Wembley. A museum attendant, with knowledge of preparing and mounting specimens—The Curator of the Museum, University College Hospital Medical School, University Street, W C 1.

Errata.—Nature of April 10, p. 516, end of penultimate paragraph in Col. 1; *for* "standard deviation, 74·7" *read* "standard deviation, 7·47."

Nature of April 17, p 557, Col. 1 The total power of the electrical machinery in the machinery hall of the Rugby Wireless Station is 1800 kilowatts and not 800 kilowatts as stated. The insulation referred to at the end of paragraph 3 as being designed for a quarter of a million volts is the insulation between antenna and earth.

Our Astronomical Column.

Magnetic 'Storm,' Aurora, and Solar Disturbance—A considerable magnetic disturbance was recorded at Greenwich on April 14, commencing with a sudden deflexion of the needles at 11 hr, and continuing until 11 hr on the following day. The extreme range shown by the Declination trace was 1¼°, and by the North Force trace 350γ. The disturbance thus ranks as 'great.' In this connexion, a letter received from Mr. Charles Leaf of Cambridge is of interest, in which he records a fairly well-marked display of the aurora borealis seen on April 14 between $21^h\ 20^m$ and $21^h\ 50^m$ G M.T, after which clouds made further observations impossible The aurora was seen as a moderately strong greenish glow exhibiting a marked 'pulsation' of intensity, no streamers were visible Mr C P. Butler of the Solar Physics Observatory, Cambridge, also observed the aurora He noted its greenish colour and that the auroral line $\lambda 5577$ was fairly bright.

At the time of these phenomena there were no large spots on the sun, although there were three comparatively small ones, and several areas of faculæ. One of the spots at the time of the commencement of the magnetic storm was 9° of solar longitude (or 0·7 day) east of the sun's central meridian. Although much diminished in size, this spot was the fourth recurrence of one of a very large pair of spots seen last December. Its earlier history has been outlined in these columns as the naked-eye spot, Nos. 1 and 4 (Nature, January 9, 30, February 27). When near the sun's central meridian on January 22 a moderate magnetic disturbance took place, but no marked movements of the needles were noted at the time of its two subsequent transits of the central meridian about February 19 and March 18

Mr. A. M. Newbegin, of Sutton, Surrey, has observed that the longitudinal zone of the sun containing this spot has produced a large prominence, which he saw with his spectroscope at the sun's limb on February 25, March 10, and March 23-24.

The Hamburg Observatory, Bergedorf—The report of the Director of this Observatory, Prof. R. Schorr, for 1924 has lately come to hand; it contains a record of numerous researches The transit circle is being used for the re-observation of stars observed by Rumker The 60-cm refractor has been used by Dr Graff for charting the stars surrounding 150 eclipsing variables, determining both their magnitude and their colour.

Dr. Baade used the reflecting telescope for photographic observations of several faint comets and interesting minor planets, including Ganymed, which he discovered He also obtained photographs of several clusters and nebulæ. He has now temporarily left Bergedorf on a visit to some of the North American observatories. Dr. Kruse has used the 26-cm. equatorial for photometric observations of variable stars, also for comets and minor planets The Lippert astrograph was used by Prof. Schwassmann and Dr. Haas for obtaining photographs and spectrograms of the Kapteyn selected areas. The exposures for the spectrograms ranged from half-an-hour to 5 hours. Dr. Haas also determined the spectral types of several faint stars for which sensible parallaxes have been found. They are mostly of late types, G to M, but B D. + 42° 3917 is of type A 3.

Progress is also being made with the "Geschichte des Fixsternhimmels" and the "Eigenbewegungs-Lexicon," which are extremely useful works of reference.

The work of detecting faint minor planets and periodic comets on their return to perihelion has been very successfully pursued

Research Items.

BLOOD CHARACTERISTICS AND RACE.—The first number (Jan.-Feb.) of vol. 36 of *Natural History*, the publication of the American Museum of Natural History, is devoted to the study of the present races of man, and contains, in addition to descriptive articles of primitive peoples, several papers dealing with anthropological questions of more general bearing. Among these is a review by Mr. R. Ottenburg of the present position of the study of the characteristics of the blood as a test of race relationship. The suggestion put forward by Dr. Hirschfeld and his wife in 1918 that the constituents known as A and B originated in Europe and Asia respectively, no longer holds good in the light of further and more extended observation. It is found that there are races in Africa, Asia, Australia, and America which show as high a proportion of A to B as do the North Europeans, the supposed exceptionally high proportion of A in the last named being the basis of Hirschfeld's conclusion. Six fundamental types are to be recognised according to the proportion of the three more common blood-groups. The European type is characterised by a relatively high proportion of Blood-group II., while two of the Asiatic types, the Indo-Manchurian and the Afro-South Asiatic on the fringes of the Indian Ocean, have more of Blood-group III. The Pacific American type, consisting almost entirely of Australian and American Indians, shows an enormous preponderance of Blood-group I. The Hunan type is remarkable in that it shows an unusual proportion of Group IV., which in every other type is the lowest. The figures seem to indicate the existence of transition races formed by the mingling of two adjacent races. The Jews apparently do not form a homogeneous group, but tend to assimilate to a local group, *e.g.* Berlin Jews to German, Spanish Jews to Arab, Rumanian Jews to Hungarian, and so on. The gypsies, however, correspond to the Indo-Manchurian type, which seems significant in view of their tradition of non-intermarriage and Central Indian origin.

AN 'EOLITH' FACTORY.—A sequel to the now famous study of the 'eoliths' produced in the course of the manufacture of cement at Mantes, which was made by Prof. M. Boule in 1905, appears in Nos. 1-2 of vol. 36 of *L'Anthropologie*. In 1924 Mr. Etienne Patte, at the suggestion of Prof. Boule, examined flints similarly produced by a cement factory at Beaumont-sur-Oise, and found them to be identical in form with the implements found in the pliocene of East Anglia for which a human origin is claimed. The method pursued in selection was identical with that followed by those who accept the Pliocene specimens as artefacts; that is, a process of repeated classification, selection, and rejection which ends in the assembly of a relatively small number bearing what are said to be indubitable traces of human purposive working. In this case the causes are mechanical, but the chipping is identical, and the result a collection of characteristic types, rostro-carinates, etc. More remarkable still, a crushing machine which consisted of two 'jaws' shod with iron, the lower being fixed, produced flakes, some of which showed an apparent secondary chipping and might have been taken for scrapers of an Upper Palæolithic or even Neolithic culture.

THE MARINE FISHES OF PANAMA.—The second part of this monograph, by Mr. S. E. Meek and Mr. S. F. Hildebrand (*Field Museum of Natural History*, Zool. Ser., vol. 15, 1925), includes the teleost fishes from the families Carangidæ to Pomacentridæ. Nine new species and subspecies are described, and in many cases a detailed study of Atlantic and Pacific forms has demonstrated differences of sufficient importance to warrant the institution of new species. The report is well illustrated, and the authors have not neglected to supply well-produced figures of hitherto inadequately figured forms. Useful working keys to the genera and species continue to form a prominent feature of the work, and, when completed, it should be an indispensable guide to the fishes of this region and yield valuable information for a detailed comparison of species and genera on both coasts of Central America.

FLUCTUATIONS IN FISHERIES.—We quite agree with Mr. B. Storrow (*Trans. Nat. Hist. Soc. Northumberland*, Nov. 1925) that to trace to their cause the fluctuations to which statistics show that all fisheries are subject, is one of the most important problems in fishery investigations, if not indeed the central problem on which all remedial measures depend. These fluctuations are seen by comparing the total landings year by year, or the catch per unit of power in unit of time. The latter is obviously the most accurate method, but boats themselves as units of power fluctuate so greatly, leaving out of all account the skill of their crews, that its measure of accuracy is not great. In any case, it cannot be applied to herring or any fish which is not distributed relatively evenly over the bottom or the surface of the sea where trawl or drift fisheries are regularly pursued. In writing on any fishery question there is always the personal factor which must come in, even in interpreting rigid facts, as exemplified by figures of catch of different areas as shown by Mr. Storrow to his readers in numerous graphs. The thesis here is that migrations of fish have more to do with fluctuations than any other factors, such as bad spawning or hatching, greater or less vitality of the young, or extraordinary occurrences causing the death of fish in vast numbers. As examples the herring, cod, haddock and mackerel are considered. Graphs are given either to show average catch per day's absence for each month, or the total catches year by year for a number of years in several areas, superimposed for each year upon one another. These should be similar if the same causes operate in all areas, but it is clearly brought out that peaks in some graphs so commonly overlie depressions in others that, if all were added together, the result would be so smoothed down that the facts would be hidden. To put it in another way, the total catch does not vary much year by year, while the catch in areas shows large fluctuations. There are great periodic changes in the flow of Atlantic waters besides minor fluctuations and, coinciding with these, are supposed to be wholesale movements of the fish themselves. Of these, statistics alone cannot give proof, which can only come by the identification of the areas from which the fish came, by markings or otherwise on the fish themselves.

CARABID BEETLES FROM THE KUMAON-TIBETAN FRONTIER.—In the *Entomologist's Monthly Magazine* for March 1926, Mr. H. E. Andrews contributes a paper on the Carabidæ obtained by Mr. H. G. Champion in the north of Kumaon and over the Tibetan frontier. During the expedition much new country was traversed at a great elevation, and the Tibetan frontier was reached near Shelshel and Laptel at about 15,000 ft. The species and varieties of Carabidæ enumerated number sixty-six, and twelve new species are described. Most of the species inhabiting the higher regions of the Himalaya are, as would be expected, palæarctic genera, and this appears to be the southern limit, at least in Asia, for a good many of them. A few, such as Dioryche and Colpodes, occur in tropical Asia and reach their northern limit in the Himalaya. Others, such as Tachys and Bembedium, are nearly world-wide. Sixteen species extend their range outside the Himalayan tract, occurring, in some instances, in Indo-China, Formosa, and the Malay Islands. One species, *Anchomenus quadripunctatus*, is holarctic in its range and extends into England.

EXPERIMENTS ON DAPHNIA.—M. Ramult records (*Bull. Internat. Acad. Polonaise Sci. et Lettres*, No 1, 2B, Jan.-Feb. 1925) observations on the effects of sodium chloride solutions, including Ringer and Van 't Hoff's solutions, on Daphnia and other Cladocera. These solutions restrain the passing of the parthenogenetic eggs into the brood-pouch; such restraining action begins to appear in N/30 sodium chloride, and in concentrations above N/10 is total. While the restraining action appears in individuals before the weakening of their other vital functions, the author thinks it may be assumed to be due to the enfeebling action of the solution on the egg-producing female. N/30 and higher concentrations exercise a restraining influence on the development of the egg, which is especially sensitive to such solutions in the membraneless condition, but after the formation of the membrane can develop in solutions up to N/16 to N/6. The eggs of the succeeding broods of the same female living in the saline solution show a decreasing resistance, probably corresponding to a lessening vitality. The different eggs of the same brood living in the solution exhibit differences in their power of development. Animals which passed through their whole development in the solution attained their maturity in the same period of time as, sometimes even earlier than, those from the normal culture. In the third generation bred in the solution (not stronger than N/15) both the period of embryonal development and of the attaining of maturity are as long as in the second generation, and the number of eggs produced by the females in the solution is not reduced. The eggs of the second generation are able to pass through their normal development in a concentration slightly higher than those of the first generation—this applies to solutions not stronger than N/20.

INTESTINAL FLAGELLATES IN TROPICAL AMERICA.—Prof R. W. Hegner (*Amer Journ Trop. Med.*, 5, May 1925) records the results of examination of stools made by him during the summer of 1924 in Honduras and in Colombia. The incidence of infection with *Trichomonas hominis* was 20·6 per cent, with *Chilomastix mesnili* 7·7 per cent., and with *Giardia lamblia* ·1 per cent. The author accounts for the high ncidence in the case of the first two (1) by the high emperature and moist climate of tropical America, which are favourable for the transmission of these flagellates, (2) by the insanitary habits of the natives, which also favour transmission, and (3) the diet, which is largely vegetable, of the general population. Prof. Hegner has previously shown that these flagellates grow and multiply rapidly in hosts that live on a vegetable diet, but they are largely eliminated from hosts that live on a meat diet. Comparison of these esults with those of Miss Jepps from the Federated Malay States and of Boeck and Stiles from the United States indicates a definite relation among human beings between a meat diet and the lower incidence of nfection with these flagellates, especially Trichomonas.

THE PERIOD REQUIRED FOR MITOSIS.—Modern methods of tissue culture permit observations on the process of mitosis and of the duration of the various phases. In view of the discrepancy in the times recorded by Levi (1916) and by Lewis and Lewis (1917), G. P Wright (*Journ. R Micr. Soc.*, Dec. 1925) has made observations on tissue from the heart of chick embryos of the 9th to the 12th day, cultivated in Pannett and Compton's saline medium to which embryonic extract had been added. Assuming that the telophase period lasts 5 min., and on this there seems to be fairly close agreement, the early prophase takes 8 min., the spireme 6½ min., the metaphase 5 min., the anaphase 4 min., the telophase 5 min., and the reconstruction 5 min.—a total of about 34 min. This is almost identical with Strangeways' record of 35 min. as the period of division of the choroidal cells of the chick, and it falls midway between the two limits, 25 min. to 45 min., found by Lambert and Hanes to be the time of division for the connective tissue cells of the rat.

A TAXONOMIC STUDY IN EVOLUTION.—From this general point of view, Mr. Francis W. Pennell examines the taxonomy of the genus Afzelia of the Scrophulariaceæ in *Proc. Acad. Nat. Sci. Philadelphia*, vol. 77, pp. 335-373, 1925. He concludes that the genus shows transition from the campanulate to rotate corolla, with a change from longitudinal to pore dehiscence in the anther of the stamen, with which change also runs a modification of the staminal filament from a broad flat hairy structure to a type with a slender, terete, glabrous distal region. Thus the flower, viewed as an organ to ensure pollination, has been so changed as to function in a new manner. Studying the distribution of the species in this genus, Mr. Pennell concludes that they show a striking disagreement with the "Age and Area" hypothesis of Dr. Willis. In Afzelia, the most modified and recent species appear to be the most widespread.

REGENERATION OF FERN PROTHALLI.—In the *Biologisches Centralblatt*, vol. 46, pp. 80-96, 1926, K. Linsbauer describes some interesting experiments on the regeneration of isolated cell groups obtained by cutting pieces out of fern prothalli. He finds that very small cell groups, which normally would have finally ceased to grow and divide, when isolated in this manner, may again begin to grow vigorously and practically give rise to prothalli. He concludes that this revival of growth cannot be traced to growth-promoting substances from the wounded cells, but to the accumulation of assimilates in the isolated prothallial fragments which normally would have been passed on to nourish the growing apical region.

CURRENTS IN THE RED SEA.—An account of current-meter measurements made during the hydrographic cruise in the Red Sea of the *Ammiraglio Magnaghi* in 1923–1924 is published by Prof. F. Vercelli, with numerous diagrams and illustrations (*Annali Hydrografici*, vol. 11). The recorded horizontal movement of the upper layers was found on analysis to be the sum of a to-and-fro tidal stream and a drift current, the latter varying with the monsoon season. The tidal streams persist throughout all depths, whereas the drift current decreases down to a depth of 100 metres in the channel off Bab-el-Mandeb, below which it reverses in direction. From the harmonic components of the tidal stream, derived from an analysis of the observed data, and the drift current, the calculated velocity of the upper layers is tabulated for every hour throughout a year. Accurate computations of the currents which will be met with by vessels navigating the Red Sea are likely to be of particular value in view of the difficulty often experienced in that neighbourhood in obtaining reliable 'sights' during the day owing to refraction.

RAINFALL IN THE NETHERLAND INDIES.—The Royal Magnetical and Meteorological Observatory of Batavia in *Verhandelingen*, No. 14, vol. 1, publishes the mean rainfall figures for 2715 rainfall stations in the Netherland East Indies, calculated from observations made during the period 1879–1922, by Dr. J. Boerema. The present publication contains nothing besides a mass of tables without a word of text. Very few of the stations are for the whole period of forty-four years, but the number of years over which the observations extend are given with each station, and the height of each station above sea-level is stated. In addition to the mean rainfall for each month and the year, the mean number of rainy days is also given, but what constitutes a rainy day does not appear to be stated; the results are in mm The mean maximum daily rainfall is also given for each month and for the year; it might perhaps have been more useful to give the absolute maximum rainfall for each month and year. A single entry of the absolute fall is given without reference to when it refers

SEASONAL WEATHER FORECASTING.—Remarks on the influence of the currents in the waters about Denmark upon the climate of Denmark and neighbouring countries by A. C. Johansen and A. J. C. Jensen, reprints from Physiological Papers, have recently been published in Copenhagen. The strength of the inflow into the Kattegat varies much from time to time, and a strong outgoing current in the surface layer is followed by a strong ingoing current in the lower layer. The authors have examined the correlation between the salinity of the bottom water of the Kattegat and the salinity and temperature of the surface water, also the correlation between the salinity of the bottom water in the Kattegat in the spring months and the air temperature in Denmark and neighbouring countries in the summer months. It is found that a high salinity in the lower layer of the northern Kattegat in April–May is normally followed by a low air temperature in June and July, and a low salinity is normally followed by a high air temperature. There is probably also a positive correlation between the salinity of the bottom water of the Kattegat in the spring months and the rainfall in Denmark in the early summer.

LEAKAGE OF CARBON DIOXIDE FROM SHIPS' HOLDS.—Special Report No. 24 of the Food Investigation Board, by Mr. A. J. Smith, describes leakage tests on two vessels (London: H.M.S.O., 1925; 9*d* net). Carbon dioxide was introduced into the empty holds, and, by analysing the gas from day to day, the amount of leakage was determined. The rate of leakage in port was increased to more than ten times its original value by opening the thermometer tubes. The leakage when the vessel was at sea was higher than when at rest in port.

TRANSMUTATION OF MERCURY INTO GOLD.—A further contribution to this question is made by Piutti and Boggio-Lera, whose results are published in the September-December issue of the *Rendiconti dell' Accademia delle Scienze Fisiche e Matematiche (Naples)*. The mercury employed was purified by repeated distillation in a vacuum, the two final operations being carried out in Jena glass apparatus under a pressure of the order 0·001 mm. This purified mercury was treated in three different ways: (1) A spark discharge was passed between electrodes of the metal in a highly evacuated tube; (2) an arc was passed between two very fine jets of the mercury in a vessel kept filled with hydrogen to prevent oxidation; (3) a fine stream of the mercury was allowed to fall through the arc passing between two specially pure carbon electrodes, also in an atmosphere of hydrogen. In no case was any formation of gold detectable, even by Stammreich's method of testing, which responds to so little as one one-millionth of a milligram of gold per kilogram of mercury. The view that mercury may undergo spontaneous transmutation into gold in Nature is suggested by the invariable presence of gold in commercial mercury, and it is possible that useful information on this phase of the subject might be acquired by the examination of deposits of cinnabar of different geological ages.

THE GLOW OF PHOSPHORUS TRIOXIDE.—Thorpe and Tutton, the discoverers of phosphorus trioxide, showed that this substance is oxidised with emission of light, and it has been suggested that the glow of phosphorus is really due to that of phosphorus trioxide formed in a preliminary reaction. It has also been suggested that in moist oxygen an intermediate substance, probably phosphine, is formed from phosphorus trioxide, and that the glow is due to this. An interesting account of the glow of phosphorus trioxide is given by Christina Cruickshank Miller in the *Proceedings of the Royal Society of Edinburgh*, 1925–6, vol. 46, part 1. It was shown that the glow depends on the presence of moisture and ceases in the absence of water. It was found that phosphine and other hydrides of phosphorus are produced, and the glow is attributed to the oxidation of these. The results throw much light on the still obscure problem of the glow of phosphorus itself.

MEASUREMENT OF HUMIDITY IN CLOSED SPACES.—Special Report No. 8 of the Engineering Committee of the Food Investigation Board contains an account of experimental work in hygrometry carried out at the National Physical Laboratory by Dr. Ezer Griffiths (London: H.M.S.O, 1925; 2*s*. net). The primary object of the investigation was to study apparatus for making humidity measurements, and a description is given of numerous forms of hygrometers devised to meet special requirements. The supreme importance of exposing the wet bulb of the wet and dry bulb hygrometer to moving air is emphasised. The special forms of this hygrometer described are: (*a*) a direct reading instrument; (*b*) instruments to enable readings to be taken without entering the enclosure; (*c*) a distant reading form The dew-point hygrometer is particularly suitable for use as a standard of reference in calibration work. Several industrial forms of dew-point apparatus are described. The hair hygrometer was given detailed study. It was found that the hai hygrometer showed a tendency to give high readings with lapse of time. The instruments which behaved most satisfactorily were those in which the tension force was small and the bearings and pivots of which were so well made that friction was reduced to a minimum A distant reading type of hair hygrometer was constructed on the Wheatstone's bridge principle. Th other instruments of this type that might be mentioned are (*a*) the form adapted for insertion into frui cases; (*b*) the combined hair and dew-point apparatus A hygrometer was constructed utilising a discovery o Orme Masson that dry cotton-wool when exposed to damp atmosphere generates heat. The instrument was constructed in the form of a differential resistanc thermometer, one coil being covered with cotton an the other by non-hygroscopic material. This type o hygrometer has certain inherent defects due t hysteresis.

Exhibits at the Optical Convention, 1926.

THE Optical Convention, 1926, was held at the Imperial College of Science and Technology, South Kensington, during the week April 12-17, under the presidency of the Astronomer Royal, supported by representatives of all branches of the optical industry and profession. An important part of the Convention was the exhibition of optical instruments and apparatus organised to demonstrate the advances that have been made in optics in Great Britain since 1912, the date of the previous Convention. During the week, more than 8000 visitors, in addition to members of the Convention, attended the exhibition. Many were attracted, no doubt, by the various entertainments and performances incorporating interesting optical illusions, but many also were attracted by a desire to study the concrete evidences of recent developments and the most modern products of British opticians, many of which, as the Prime Minister pointed out during the opening ceremony, are recognised the world over as achieving the high water-mark of technical perfection.

Considerable development might be expected in an industry during a period of fourteen years. When it is remembered that during part of that period, development was quickened by the urgency of war-time requirements, and later by the necessity of meeting fierce competition arising from depreciated foreign exchange rates, and also of keeping pace with rapid advances in science, it can easily be imagined that the manufacturer had a wide range from which to choose his exhibits.

Optical glass, the most important of the optician's raw materials, was exhibited in the rough lump and in the form of moulded slabs, disks and prisms by Messrs. Chance Bros. and Co., Ltd., and by Messrs. Parsons' Optical Glass Co. The latter firm exhibited a disk of hard crown glass, 32 in. in diameter, suitable for use in a 30-in. aperture telescope object-glass. Specimens of dense barium crown glass shown by Messrs. Chance Bros., illustrated the improvement in quality, particularly in regard to freedom from colour and bubbles, which has been effected in recent years in the production of this difficult glass. This firm now makes more than 100 different types of glass suitable for optical purposes, many of which were not manufactured before the War.

Some of the uses to which these new glasses have been put were well illustrated by the extensive range of new types of photographic lenses exhibited. The Ross Xpres and the Taylor-Hobson Aviar lenses were designed and produced during the War to meet the demand for large-aperture lenses giving the high quality of definition required in air photography. Further developments in the direction of the production of rapid anastigmats were represented by Messrs. Taylor, Taylor and Hobson's f/2·5 lens, suitable for reflex cameras, and also their f/2 anastigmat, which has a covering power of 55° and represents the limit so far reached in the production of wide angle, large-aperture lenses. Another exhibit by the same firm was a series of f/3·5 telephoto lenses, which marks an important advance in telephoto construction. This advance has been shared by the Teleros lenses of Messrs. Ross, Ltd., who had on view a 40-in. lens of that series fitted to a Ross Sports camera. Telephoto lenses of recent design were also exhibited by Messrs. J. H. Dallmeyer, Ltd., and by Messrs. Wray (Optical Works), Ltd.

The remarkable developments that have been effected in British-made surveying instruments were well shown in the various types of theodolites and levels exhibited by Messrs. C. F. Casella and Co., Ltd., Messrs. Cooke, Troughton and Simms, Ltd., Messrs. W. Ottway and Co., Ltd., and Messrs. E. R. Watts and Son, Ltd. These improvements have been largely directed towards securing optical perfection, reduction in dimensions and weight, greater rigidity, more effective guarding of vulnerable parts, and the introduction of means for saving time and labour in the making of observations. In the precise levels exhibited by these firms, the telescope with the attached bubble can be tilted independently of the vertical axis, which greatly facilitates and expedites field work. Provision is also made on many of the instruments for reading the bubble, the compass bearing, and the staff, from the telescope-end position, without change of position on the part of the observer. Messrs. Cooke, Troughton and Simms and Messrs. Watts exhibited levels embodying reversible bubbles, the use of which simplifies the adjustment of the instrument. Further simplification in the use of Messrs. Watts' instruments have been effected by the introduction of their "constant" bubble, which is so constructed that changes of temperature within the range 0° to 130° F. produce no change in the length of the air bell. Thus, when the instrument is being set it is necessary to observe only one end of the bubble.

With the exception of a few standard instruments or parts of instruments, the microscope apparatus exhibited by Messrs. C. Baker, Messrs. R. and J. Beck, Ltd., Messrs. Negretti and Zambra, Messrs. Ogilvy and Co., Messrs. James Swift and Son, Ltd., and Messrs. W. Watson and Sons, Ltd., represented an entirely new series of instruments and appliances for microscopical work computed and designed since the last Convention, and including all types of microscopes and microscope accessories such as are required for students' use, for industrial processes, for scientific investigations and for all classes of laboratory and research work. The modifications that have been introduced involve many important changes in mechanical design and construction, and also improvements in optical properties. One of the most striking alterations in mechanical design is that shown in the Beck Radial microscope. The general design is that of a small optical bench so arranged that as the inclination is changed from the vertical to the horizontal, or any intermediate position, the centre of rotation remains in the optic axis. The advantage of this arrangement is specially apparent in metallurgical work when a vertical illuminator is used. The adjustment, being once set, is not altered by the inclination of the instrument or by the focussing.

Of the many important instruments exhibited by Messrs. Adam Hilger, Ltd., the most outstanding were the Hilger interferometers, including those for demonstration purposes and for the examination of prisms and lenses, and the latest model, the Universal camera lens interferometer, which permits of the examination of all ordinary photographic lenses up to a clear aperture of 5¼ in., and from 4 in. up to about 33 in. focal length, as well as lenses of the telephoto type, process lenses, complete telescopes up to a total length of 12 in., and eyepieces. On this firm's stand were also a complete range of Hilger wave-length spectrometers, a permanent adjustment quartz spectrograph giving a spectrum from 2100 Å.U. to 8000 Å.U.; a vacuum spectrograph for the study of the furthest ultra-violet region, in which a concave diffraction grating of 2 metres radius is used, and the Hilger ultra-violet spectroscope provided with a fluorescent screen from which the wave-length may be directly determined Messrs. Bellingham and Stanley, Ltd, also exhibited quartz spectrographs and a range of polarimeters and spectrometers, including a compact instrument for the examination of the entire spectrum giving readings directly in wave-lengths

The ophthalmic section of the industry was well represented by about twenty-five different exhibitors. Many new types of spectacle lenses, eyeglass mounts and spectacle frames were shown. The ophthalmic instruments on view illustrated the development of apparatus for the detection of pathological conditions of the eye, as well as those for the mechanical measurement of visual errors. Among these may be mentioned the self-registering perimeters exhibited by several firms, the photographic ophthalmoscope, exhibited by the Cambridge Instrument Co., Ltd., by means of which it is possible to obtain photographs of the fundus showing both the optic disk and the macula lutea on one plate, and the combined corneal microscope and slit lamp, exhibited by Messrs. Clement Clarke, Ltd, in which both the illuminating system and the microscope are mounted on an arc which has its centre of curvature at the focus of the illuminating beam.

It is, of course, quite impossible in an article of reasonable length to give anything approaching a full list of the various interesting pieces of apparatus on view and described in the 320-page catalogue prepared for the use of the members of the Convention. In the preceding paragraphs reference has been made to only a few of the items on the stands of a few of the trade exhibitors, and many important items in important groups of instruments have had to be omitted.

The educative value of the exhibition was enhanced by the inclusion of a section devoted to optical instruments and apparatus designed by research workers for use in scientific investigations. These included an instructive collection of apparatus exhibited by the National Physical Laboratory, Teddington; the Technical Optics Department of the Imperial College of Science and Technology, South Kensington; the Department of Applied Optics, Northampton Polytechnic Institute, London; the Refraction Hospital, London; and by other institutions and scientific workers. Mention should be made of the selenium apparatus designed by Dr. E. E. Fournier d'Albe and E. O. Symonds for registering mechanically the passage of interference fringes, the Clarendon photoelectric photometer, exhibited by Prof. F. A. Lindemann and Dr. G. M. B. Dobson, by means of which very small areas, such as spectral lines on a photographic plate, can be measured to a high degree of accuracy; and the series of instruments exhibited by the Cambridge Instrument Co, Ltd., in which the stylus-on-celluloid method is used for recording various physical phenomena.

The historical section of the exhibition contained a valuable loan collection of more than 350 items of great historical importance, illustrating the evolution and development of various types of optical instruments and indicating the types actually made and in use at different periods. Our admiration for the many highly developed and finished products of modern science in the adjoining sections did not in any way detract from our admiration for these optical treasures of past generations, for did not each one represent a modest though none the less distinctive landmark along the path of optical progress? The magnificent and impressive display of present-day apparatus, instruments and methods which formed the Optical Convention 1926 Exhibition marks the farthest point yet reached along that path.

The Intermittent Theory of Radiation.

AN important paper on "The Intermittence of Electric Force" was read by Sir J. J. Thomson to the Royal Society of Edinburgh on December 21 We now know that the atom is made up of electrons and positive charges, and that the number of electrons in the atom of an element is equal to the atomic number of the element. We also know the masses of the electrons and the positive charges If, therefore, they obeyed the ordinary laws of electrostatics, we could calculate by the laws of dynamics the behaviour of the atom. The behaviour predicted in this way is not in accord with experiment. The reason of this discrepancy is doubtless that in the atom we are concerned with effects which occur in times and in distances very much shorter than those which occurred in the experiments by which the laws of electric force were discovered or tested.

Sir Joseph directs attention to the possibility of the electric force being intermittent in its action. The intermittence is so rapid that its effects are only apparent when we are dealing with events which occur in intervals as short as those in the atom. He illustrates this point by considering the properties of gases. So long as we test these properties on an 'engineering scale' they are completely explained by supposing that the gas exerts a continuous pressure on the walls of the containing vessel and that it obeys the hydrodynamical laws for a continuous fluid. It is known, however, that the pressure is not really continuous but consists of a succession of isolated blows following each other irregularly at very small intervals of time. By the methods now available for producing very high vacua we can get the gas in a state where it is impossible to explain its behaviour by the hypothesis of continuity. The gas has a structure in time, the fineness of which is determined by the interval between the collisions. The fineness of the structure for a given gas varies with the pressure, being coarse at low pressure and fine at high pressure

Sir Joseph supposes that the electric field has a structure in time, so that instead of the electric force being a continuous effect consisting of a continuous flow of momentum into the body under its action, it is really discontinuous and consists of finite increments of momentum separated by finite intervals of time This discontinuity in the nature of the force readily explains the occasional spontaneous dissociation of a system. It also gives a reasonable hypothesis to explain why a system sometimes radiates away its surplus energy as Rontgen rays.

The assumption of the intermittence of electric force leads to startling results when applied to light waves. The mathematical proofs given indicate that there can be no unlimited propagation of light waves diverging from a source. The waves must ultimately reach a region where they are reflected back.

It will thus be seen that the hypothesis demands a corpuscular theory of light. The energy of the light must be done up into batches which retain their energy undiminished as they travel out into space. This does not exclude, in fact it requires, the presence of electrical waves of Maxwell's type. We must picture the light unit as a central quantum vibrating with the period of the light and emitting electrical waves. None, however, is allowed to escape, and the energy lost by the quantum in radiation is restored to it.

Light, therefore, has a dual character. It consists of electrical waves and the quantum. The electrical waves give rise to interference effects and the quantum to photo-electric effects. The energy in the electrical waves surrounding the quantum does not alter as the system travels through space, and so the ratio of the energy in these waves and that in the quantum remain invariable. The mathematical proofs based on the theory of probability given in this paper are very neat and very easy to understand.

In a paper read before the Royal Society of Edinburgh on February 8, Prof. E T. Whittaker follows up Sir J J. Thomson's paper and shows that the Maxwell-Lorentz equations can easily be modified so as to represent Sir Joseph's ideas regarding light. What distinguishes Thomson's theory from the work of all other writers on the subject is that he pictures the structure of the light-quanta in terms of tubes of electric force When light is generated he invites us to picture a closed part of a loop in a tube of electric force to become detached and go off as a closed ring. This ring soon becomes circular and travels with the velocity of light in a direction at right angles to its plane, like a circular vortex ring. The energy of the ring remains constant until the ring is broken It is known, for example, that if cathode rays fall on a metallic plate and generate X-rays which fall on a second metallic plate, electrons are ejected from the second plate and their energy is of the same order as that of the electrons in the primary cathode rays and is independent of the distance of the plates.

The only explanation seems to be that the energy of the X-rays is contained in compact parcels between the plates. This phenomenon has led Einstein and other physicists to advocate corpuscular theories of light. In Thomson's theory we picture something similar to a procession of rings of cigarette smoke, moving forward through the air in front of the mouth of a smoker As the group moves through space, it sweeps over the interior of an infinitely long, straight cylinder, the axis of which is in the direction of propagation. Everywhere outside this cylinder the field is permanently null

Sir Joseph points out that it is not necessary to suppose that light consists exclusively of a procession of 'electric vortex rings' He considers that it consists of rings of electric force accompanied by Maxwellian waves These rings sometimes vibrate and produce waves of the type ordinarily considered Whittaker gives a justification of Thomson's hypothesis and a verification of the quantum relation.

Salient Features in the Stratigraphy, Tectonic Structure, and Physiography of the Commonwealth of Australia.[1]

A BRIEF summary of the salient features of the stratigraphy of the Commonwealth is essential for understanding its tectonic structure Pre-Cambrian rocks are developed in Western, Central, and South Australia The Proterozoic rocks of Northern Australia are partly formed of thick dolomites, possibly a forerunner of the Great Barrier Reef of to-day. Basic lavas and tuffs, 3000 feet thick, preceded a great ice-age in late Proterozoic or early Cambrian time Marine Cambrian strata occur chiefly in Northern and Central Australia and South Australia, with patches in Victoria, Tasmania, and Queensland Ordovician rocks attain a thickness of 40,000 feet in Victoria and Central Australia Igneous intrusions and unconformity separate the Ordovician rocks from the Silurian In the Devonian rocks of Queensland, coralline limestone, 7000 feet thick, is probably another ancestor of the Great Barrier Reef. In Carboniferous time a south-eastern shore of 'the Tethys Sea' is well defined in the north-west of Western Australia Carboniferous and Devonian time were periods of granitic intrusions and effusive rocks. In Permo-Carboniferous time half Australia was under ice This was the chief coal-forming epoch, followed by more coal (in Triassic and in Jurassic times) developed in immense epicontinental lakes in eastern and central Australia, near which carnivorous deinosaurs existed.

Marine Jurassic strata in Australia are only found in 'the Tethys Sea' of Western Australia The great dolerite-sills (comparable with the Karroo dolerites) of Tasmania possibly closed Jurassic time Cretaceous time witnessed great peripheral and central marine transgressions. The Neocomian Sea was probably cold, and epeirogenic uplift in east Central Australia replaced marine by lacustrine conditions; this uplift was probably accompanied by small local glaciation. In Western Australia the last of 'the Tethys Sea' is represented by the Lower Santonian with Uintacrinus (comparable with the Arriloor Beds of Southern India) Cretaceous strata were slightly folded in pre-Oligocene time. Eocene marine deposits are mostly wanting except, perhaps, in New Guinea, but the Winton series may be partly Eocene

Oligocene time was one of very extensive peneplanation, which was prolonged into the Miocene, and in places into early Pliocene time. A rock-crust, or 'petroderm' ('Hartrinde' of Walther) formed over the more arid parts of this peneplain Marine transgressions occurred all along the southern coast of Australia, mostly following on the eruptions of the 'older basalts.'

In Miocene time there were warm seas with large foraminifera (Lepidocyclina) and reef-forming corals, even in Tasmania The earliest marsupials are found there in the Miocene beds. Miocene brown-coal deposits up to 800 feet thick, formed partly of Fagus and Banksia, occur in Victoria 'Deep leads' of gold and tin were formed inland. In New Guinea the oil-belt was developed during the Miocene Period.

In Pliocene time the whole peneplain underwent differential movement which was strongest in eastern Australia. Alkaline lavas were erupted from tensional fault-planes in the old peneplain. Epeirogenic uplift (during the 'Kosciusko epoch' of E C. Andrews) now followed, and became accelerated in a late Pliocene epoch. The Rift Valley of Australia formed mostly during this uplift This later movement was accompanied by widespread eruptions of basalts with some andesites The Great Barrier Reef was already forming, and possibly commenced to develop—even earlier.

The southern edge of the Lake Eyre peneplain became tilted northwards, and that of Western Australia eastwards, bringing about interior drainage and local aridity The Pleistocene ice-age followed, together with a pluvial epoch, when Lake Eyre once more drained seawards Crocodiles and gigantic marsupials were then abundant in Central Australia The Tasmanian aborigines arrived in Tasmania by way of the Malay Bridge, possibly during a eustatic negative movement of the sea. As the Ice Age ended, the sea-level rose, drowning the coastal valleys. The rainfall decreased. Lastly, the Australian aborigines arrived, perhaps bringing with them the dingo. In the last few thousands of years the sea-level has fallen by about 15 feet.

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[1] Substance of a lecture delivered by Sir T W Edgeworth David, K B E., F R S., before the Geological Society of London on March 29.

The salient features in the tectonic structure were briefly discussed, with especial reference to Suess's views as to the arrangement of the Australian arcs, and the physiographic features, chiefly with reference to the phenomena of arid erosion. The origin of the inland sand-hills of Central Australia is attributed to the disintegration of the widespread Permo-Carboniferous sandstones, for the later seas of that period transgressed over large areas of Australia, possibly in part through a eustatic rise of sea-level following on the melting of the great Permo-Carboniferous ice-sheets.

Ventilation and Comfort.

THE Medical Research Council has published a report on the "Methods of Investigating Ventilation and its Effects," by H. M. Vernon and others (Special Report Series, No. 100. Methods of Investigating Ventilation and its Effects. London: H.M. Stationery Office, 1926, 2*s.* net). Part 1 contains descriptions of two new instruments for the measurement of variations (*a*) in the velocity and (*b*) in the temperature of air currents. For the former purpose a new form of hot-wire anemometer was constructed which is very sensitive to changes of air velocity, while influenced little by changes in temperature. For the latter purpose a suitable thermopile was devised which was unaffected by changes in velocity. The combined use of these two instruments has thrown further light on the relative importance of temperature and air movement in ventilation. In Part 2 the results of a further calibration of Leonard Hill's kata-thermometer are given, which allow low-air velocities found in ordinary rooms to be measured with far greater accuracy.

Part 3 consists of an investigation of the extent to which objective indications of the kata-thermometer correspond with actual sensations of comfort. Acclimatisation is shown to have an important influence. It is concluded that the cooling power of 6, fixed as the minimum for sedentary workers in Great Britain by Leonard Hill, may reasonably be 5 for people acclimatised to summer weather, and 7 for people acclimatised to winter weather. "It was found that the various degrees of 'stagnancy' experienced in factory air were due to differences in the air temperature, whilst the various degrees of 'freshness' were due chiefly to differences in air velocity. The cooling power of the kata-thermometer combines these two variables better than any other known measure, and the correlation ratio of cooling power on air sensation was found to be 703 in summer and 790 in winter."

In Part 4, Dr. Vernon has studied the rate of cooling of the human body, as shown by fall of mouth and rectal temperatures, naked and clothed, after being warmed up by previous exercise, and has in this way thrown further light on the relative importance of air temperature, clothing, and air movements. The results tend to show that in order to induce cooling of men engaged in hot and heavy work, it is of most importance to reduce temperature and next clothing, small increase of velocity of air having comparatively little effect.

Work now in progress in the new wind tunnel built at the National Institute for Medical Research shows, however, that velocity can have a very great effect on warmly clad men, when it is sufficient to drive air through and so ventilate the clothing. By means of wind sufficient to evaporate the sweat effectively, men can be kept much more comfortable, and will in consequence work better, in hot atmospheres.

University and Educational Intelligence.

LONDON.—A University chair of bacteriology and immunology, tenable at the London School of Hygiene and Tropical Medicine, and a University chair of epidemiology and vital statistics, tenable at the London School of Hygiene and Tropical Medicine, have been instituted.

The following courses of free public lectures are announced: "The Influence of Water on Vital Processes," by Prof. J. B. Collingwood, at University College, on April 26, May 3, 10, 17, 24, and 31, at 5.30; "The Integration of the Circulation," by Prof. R. J. S. McDowall, at King's College, on April 27, May 4, 11, and 18, at 4.30; and "The Nature and Functions of the Fasciæ of the Human Body," by Prof. J. Kay Jamieson, at King's College, on April 30, May 7 and 14, at 5.30.

Applications for grants from the Dixon Fund for assisting scientific investigations, accompanied by the names and addresses of two references, must be made to the Academic Registrar, University of London, South Kensington, S.W.7, before May 15, and those for grants from the Thomas Smythe Hughes Fund for assisting Medical Research, accompanied by the names and addresses of two references, not later than June 15.

APPLICATIONS are invited by the Ministry of Agriculture and Fisheries for not more than five agricultural scholarships tenable for two years and annually of the value of not more than 200*l.*, plus, possibly, extra allowances for travelling and subsistence whilst the scholars are abroad. The application form, A.189/T.E., must be returned to the Secretary of the Ministry, 10 Whitehall Place, S.W.1, by June 30 at latest.

IT was stated in the House of Commons last week by Lord Eustace Percy, President of the Board of Education, that the Government is in general agreement with the recommendations of the Departmental Committee on the University of London, and that it is proposed to introduce legislation for the purpose of setting up a statutory Commission for the University accordingly.

THE presentation portrait of the late Sir Sydney Russell-Wells, painted by his nephew, Mr. John Wells, R.I., will be unveiled in the staff room of the Dreadnought Hospital, Greenwich, by Sir Humphry Rolleston, Bart., at 3 o'clock on Tuesday, May 4. The portrait, which has been subscribed for by the friends and colleagues of the late Sir Sydney Russell-Wells, represents Sir Sydney in his robes as Vice-Chancellor of the University of London. Those desiring to be present at the ceremony may obtain cards of invitation on application to Prof. R. Tanner Hewlett at the Seamen's Hospital, Greenwich.

THE Court of the Worshipful Company of Poulters has agreed to offer a scholarship of 60*l.* per annum for two years tenable at the Harper Adams Agricultural College, for the training of persons to be instructors in the practice and science of poultry husbandry. Candidates must be British-born and not less than sixteen years of age on October 1, 1926. They must produce satisfactory certificates of character and physical fitness, and should have passed an examination of matriculation standard. The successful candidate will be required to take an approved course of study leading to the National Diploma in Poultry Husbandry. The award will be made on the recommendation of the Principal of the Harper Adams Agricultural College, to whom all inquiries should be addressed.

Contemporary Birthdays.

April 25, 1862. Viscount Grey of Fallodon, K.G., F.R.S.
April 25, 1859. Mr. Henry R. A. Mallock, F.R.S.
April 25, 1874. Senatore Marconi, Hon. G.C.V.O.
April 26, 1879. Prof Owen W Richardson, F.R.S.
April 27, 1845. Dr. Douglas W. Freshfield.
April 28, 1856. Mr. Charles E. Stromeyer, M.Inst C.E.

Viscount Grey was educated at Winchester and Balliol College. A former president of Armstrong College, Newcastle, he was, until eyesight disabilities intervened, interested in most departments of natural history pursuits, to one of which he contributed a useful work, "Fly-Fishing" (1899).

Senatore Marconi was born at Griffone, near Bologna. His first and tentative experiments in wireless telegraphy were made in Italy in 1895. Coming to England in the following year, with an introduction to Sir William Preece, F.R S., who was then engineer to the Post Office, Marconi received marked encouragement at his hands at a crucial period, as also from Prof. J. A Fleming, F.R.S. In 1899 he was able to establish wireless communication across the English Channel, later (1901) between a station at Poldhu, Cornwall, and Newfoundland. The story is continued in a stream of later improvements, inventions and researches of various kinds, of which perhaps the most distinctive practical application (in alliance with other minds) is broadcasting. In 1909 Senatore Marconi shared the Nobel prize in physics with Prof. Braun.

Prof Richardson, one of the Royal Society's Yarrow research professors in physical science, was born at Dewsbury. He was educated at Batley Grammar School and Trinity College, Cambridge. Formerly professor of physics in Princeton University, U S.A., he returned to become Wheatstone professor of physics in the University of London (King's College) Prof. Richardson received the Hughes medal of the Royal Society in 1920 for his work in experimental physics, and especially thermionics. In the following year he was president of Section A of the British Association.

Dr Douglas Freshfield, the distinguished geographer and mountaineer, a former president of the Royal Geographical Society and one of the staunchest supporters of that institution, was educated at Eton, and graduated at University College, Oxford. His interest in mountain-climbing was already established more than fifty years ago, for it was in 1872 that he undertook for a considerable span the editorship of the *Alpine Journal*. "I have always tried," he once said, "to prevent mountaineering from becoming a mere form of sport. By precept and example I have done my best to persuade my comrades to keep their eyes open to all the interest, historical, scientific, and artistic, in which the mountains abound." Dr. Freshfield received the founder's gold medal of the Royal Geographical Society in 1903, and it is interesting to recall that Dr. Sven Hedin received a medal at the same time. Apart from contributions to physical geography in the Caucasus, Dr. Freshfield's valuable work in promoting geographical education was the subject of special comment He is the author of a life of Horace Benedict de Saussure.

Mr C. E. Stromeyer, for many years engineer to the Manchester Steam Users' Association, was born at Sutton. His book, "Marine Boiler Management and Construction," is a standard of reference.

Societies and Academies.

London.

Linnean Society, March 18.—**J. L. Sager**: Phyllody of the corolla in *Primula vulgaris* Huds. The specimens come from a plant growing in a garden in Exeter, all flowers of which show this monstrosity The petals are like the foliage leaves in all respects except size. The revolute venation characteristic of the leaf shows well in these petals. Calyx, stamens, and pistil appear normal. Mr. Samuel E Steer found this plant growing in a disused burial-ground at Lympstone, South Devon, in March 1925. He transferred it to his garden, where it has increased in size, and is now bearing about twelve flowers, all abnormal.—**R. T. Gunther**: An account of the early manuscript herbal of *Apuleius Barbarus*, which has been stated to have been written in A.D 1100 and illustrated in the monastery of Bury St Edmunds, it may therefore be the oldest-known English botanical work.—**G. P. Farran**: Biscayan plankton collected during a cruise of H.M.S. *Research*, 1900. (Pt. XIV.) The Copepoda. The Copepoda collected in deep water off the Bay of Biscay were mainly taken in numerous horizontal hauls with open tow-nets by day and night down to 100 fathoms, and by vertical hauls with closing nets by day down to 2000 fathoms. The horizontal hauls show a marked difference between day and night distribution, the population above 100 fathoms being approximately doubled by night by the upward migration, in large numbers, chiefly of *Metridia lucens*, *Pleuromamma robusta*, and *Pleuromamma gracilis* In the vertical hauls the maximum number of species was found between 500 and 700 fathoms, and of specimens between 150 and 250 fathoms. The average number of specimens per 100 fathoms vertical haul between 1500 and 2000 fathoms was only 4·6, and not all of them alive, as against 781 specimens between 150 and 250 fathoms. **Helena Bandulska**: On the cuticles of some fossil and recent Lauraceæ. The possibility is demonstrated of interpreting certain elements of the floras of the past by a comparative study of their cuticles with those of recent forms. By this means the Lauraceæ have been found to be the most abundant fossils with cuticle preserved in the Bournemouth Eocene; many have lanceolate leaves with pinnate venation and strong midrib Three species of Aniba and various species of Neolitsea, Litsea, and Lindera have been discovered. The physiological characters of the fossil Lamaceous cuticles described are such as at the present time are associated with the need for controlling transpiration, and may be of assistance in the interpretation of the nature of the flora and the climate of Middle Eocene time.

The Physical Society, March 26.—**Ivor Backhurst**. Obliquity corrections in radium estimation. Formulæ are given for obliquity corrections in radium estimation applicable to sources of the shapes most frequently occurring in practice The effect of scattered radiation is considered, and some experimental results obtained are shown graphically and compared with theory.—**Albert Griffiths** and **P. C. Vincent**: Viscosity of water at low rates of flow determined comparatively by a method of thermal convection. A method is described of determining the coefficient of viscosity of water by measuring the rate of convective flow in a long capillary tube, the driving head being obtained by the difference in density due to a difference of temperature between two vertical columns of water. The results show that the viscosity of water at low rates of shear in glass tubes is apparently no different from that at high rates. Novel features are (1) the method of obtaining the driving head; (2) the new method of introducing a coloured index in a closed capillary circuit, and an improved method of reading its position; (3) the almost complete elimination of what may be called the thermometric effect as distinct from the convective effect; (4) the elimination of the small residual thermometric effect from the final calculations.

PARIS.

Academy of Sciences, March 15.—H. **Deslandres**: The aurora borealis and magnetic perturbation of March 9, 1926, at the Meudon Observatory. A bright aurora borealis was observed at Meudon on March 9; its duration was short and coincided with a marked deviation of the magnetic declination registered on the magnetograph.—A. **Cotton**: An observation of the aurora borealis on March 9; observed at Sèvres. A magnetic disturbance was recorded at the Val Joyeux Observatory.—B. **Baillaud**: Remarks on the Catalogue of Fundamental Stars of the Paris Observatory.—Pierre **Copel**: A property of skew curves and its application to the demonstration of Beltrami's theorem.—Nicolas **Kryloff**: A method of approximate integration containing as particular cases the method of W. Ritz and that of least squares.—Leonida **Tonelli**: The method of adjunction in the calculus of variations.—— **Hadamard**: Remarks on the preceding communication.—Joseph **Pérès**: A theorem concerning the movement with two parameters of a solid.—— **Rogoff**: A rectangular plate supporting a load P concentrated at its centre.—Louis **Roy**: The propagation of waves on the elastic line with four parameters.—L. **Dunoyer**: A condensation pump working with a moderate primary vacuum. A description, with diagram, of a glass mercury vapour pump. Starting with a water-pump vacuum (10 to 30 mm. mercury), the pump is working within four minutes of lighting the burner.—Jean **Dubief**: The law of viscosity of fluids as a function of the density. Its relations with the equation of state.—Y. **Rocard**: The diffusion of light in liquids.—Mlle. O. **Jasse**: The structure of the bands 4511 and 4123 of the carbon monoxide spectrum. These bands have a more complex structure than Hulthén's band, but belong to the same class.—G. **Lejeune**: Contribution to the study of the oxidisability of organic substances.—Jean **Cournot**: The cementation of ferrous alloys with aluminium. The cementation of mild steel with aluminium is best carried out by heating in a muffle with finely powdered ferro-aluminium containing a little ammonium chloride.—T. **Karantassis**: Double decompositions between the halogenides of tin, arsenic, antimony, bismuth, silicon, titanium.—Maurice **Delaville** and Paul **Carlier**: The estimation of small quantities of potassium. The metal is precipitated as cobaltinitrite, and the cobalt determined by nitroso-β-naphthol. Working with quantities of potassium of the order of 1 mgm., the error is less than 3 per cent.—V. **Hasenfratz** and R. **Sutra**: The oxidation of harmaline and bromoharmaline.—R. **Lantz** and A. **Wahl**: A new synthesis of phenylrosinduline.—H. **Arsandaux**: The eruptive origin of the basic gneiss of Djabataouré (Togo).—Auguste **Loubière**: The flora and relative level of middle coal measures of Gages (Aveyron).—P. **Choux**: Some new Sapindaceæ of Madagascar.—A. **Guilliermond**: The action of the methods of silver impregnation on plant cells and on the relations of the vacuome and Golgi's apparatus.—Albert **Petit**: Contribution to the cytological and taxonomic study of Bacteria.—L. **Hackspill** and A. P. **Rollet** and Maurice **Nicloux**: The argon in the blood. From the results of the experiments cited, the authors conclude that argon, like nitrogen, is found in defibrinated blood in quantity corresponding to its solubility and to its partial pressure in air. The blood clot, dried in a vacuum, and burnt in the presence of copper oxide, gives no argon.—L. **Fage** and R. **Legendre**: The swarming and lunar rhythm of *Eulalia punctifera*.—P. **Sédallian** and J. **Loiseleur**: The fractionation of serum proteids and the freeing of antidiphtheric serum from albumen. The method is based on the gradual addition of sodium chloride, starting with serum of pH 4·7.—S. **Posternak**: The distribution of phosphorus in the serum and red blood corpuscles of the blood.—Louis **Léger**: A new Microsporidia with spiny spore cases.—S. **Metalnikov** and V. **Chorine**: The part played by Hymenoptera in the infection of *Galleria mellonella*.

March 22.—H. **Deslandres**: The magnetic disturbance of March 5, 1926, and the disturbances of the first months of the year. A magnetic storm was recorded by the apparatus at the Meudon Observatory, and at the same time auroral lights were noted at two different places—Grainville and Neauphlette. It is shown that there is a definite relation between the periods of these magnetic storms, since the intervals of time between the storms are multiples of the time of synodic rotation R.—Henry **Le Chatelier**: The theory of the furnace.—André **Blondel**: The measurement of the photometric yield of optical apparatus (objectives, telescopes, etc.).—G. **Friedel**: The radiograms of mixed crystals. Mixed crystals obtained by isomorphous crystallisation give radiograms which do not differ from those which would be given by a simple crystal of the mean parameter From this it is generally admitted that the mixed crystal will be like the pure crystal, governed by a strictly defined period, the mean of the pure constituent crystals. This view is adversely criticised, and it is shown that there is a serious limitation to the power of penetration of radiographic analysis, especially in cases where there may be isomorphous mixtures or pseudo-paramorph structures.—L. **Cuénot**: Description of a Tardigrade new to French fauna. This is intermediate between the uncovered Oreella and armoured Echinisci, and is a type of a new genus Parechiniscus, to which is given the specific name of Chitonides.—Jean Charcot was elected a free Academician in succession to the late E. **Tisserand**.—A. **Sainte-Laguë**: Unicursal and bicursal networks.—E. **Grynaeus**: The differential geometry of Euclidian space with constant curvature.—E. **Vessiot**: Conformal geometry of surfaces.—Maurice **Gevrey**: The analytical nature and prolongation of solutions of non-linear equations of elliptic and parabolic types with one variable.—J. **Favard**: Nearly periodic harmonic functions.—Boris **Grinberg** and Maurice **Paschoud**: The torsion of a hollow cylinder the section of which is limited by two excentric circles.—Pierre **Henry**: The velocity of deformation of metals at high temperatures.—Charles **Platrier**: Periodic winds and critical wind squalls for the flexion of pillars.—A. **Chatillon**: The different magnetic states of cobalt chloride.—V. **Posejpal**: The quantitative experimental control of the resonance absorption of X-rays.—Louis **Longchambon**: The rotatory dispersion of camphor. A criticism of the conclusions arrived at by applying the formula of Lowry and Cutter to the experimental results of the rotatory power of camphor in acetone.—Miramond de **Laroquette**: The ionometric measurement of X-rays incident per unit surface and X-rays absorbed per unit volume.—Pierre **Auger**: The amount of fluorescence in the X-ray region.—H. Colin and Mlle. A. Chaudun: The variations of the constant of hydrolysis with the concentration of sugar. The experiments are not in agreement with the hypothesis that the hydrogen ions alone produce the reaction; the nature of the acid and the viscosity of the solution also intervene.—H. **Forestier** and G. **Chaudron**: The thermomagnetic study of some ferrites. Ferrites of the general formula $Fe_2O_3.MO$ have been prepared, where M may be nickel, copper, lead, barium, calcium, cadmium, or zinc, and the variations of the magnetisation coefficient with temperature determined.—M. **Holweck**: The critical *K* potentials of light atoms. Reply to a note of A. Dauvillier.—Marcel **Laporte**: The mobility of the ions in gases. The author's experiments are not in agreement with the view that for a given gas the ions have one mobility only: the hypothesis that there may be several ion mobilities is discussed.—Jules **Ventre** and Emile **Bouffard**: The influence of sugar on the estimation of ammonia in grape must.—J. **Bougault**: An example of an oxide ether of a ketone hydrate.—Marcel **Bouis**: The synthesis of ethylallene $C_2H_5.CH:C:CH_2$.—F. **Salmon-Legagneur**: Mixed ketones derived from the a-mononitrile of camphoric acid.—A. **Demay**: The genesis of the granulitic gneiss of the Pilat massif, near Saint-Etienne.—L. **Petitjean**: New researches on the displacement of (meteorological) discontinuities.—Louis **Besson**: The influence of the temperature of one month on that of the following month. According to A. Angot, the temperature of any one month has no influence on that of the following month. A statistical study of 100 years' observations made at the astronomical and Montsouris Observatories does not confirm this view. A warm January is followed by a February with a temperature above the normal 13 times out of 19 at one observatory and 8 times out of 12 at the other. Similarly a cold February is followed by March with a temperature below the normal.—Mme. P. **Lemoine** and G. **Delepine**: Discovery of the genus Solenopora in the Jurassic of France.—Lucien **Daniel**: New researches on the heredity acquired by grafting on *Helianthus Dangeardi*.—M. and Mme. Fernand **Moreau**: Sexual reproduction in lichens of the genus Collema and the theory of Stahl. Observations opposed to the Stahl theory of sexual reproduction in Collema.— — **Aversenq**,— **Jaloustre**, and— **Maurin**: The development of *Ricinus communis* in a culture medium rendered radioactive by the addition of thorium-*X*. Thorium-*X* in small doses (10 micrograms every fifteen days) improved the general development of the castor oil plant, the increase in the number and quality of the seeds being especially marked.—Antonin **Nemec** and Mihovil **Gracanin**: The influence of light on the absorption of phosphoric acid and potash by plants. — — **Parat**: The constitution of the Golgi apparatus and of the idiozome; true and false dictyosomes.—Boris **Ephrussi**: The unequal acceleration of the different phases of cell division by rise of temperature.—M. **Bridel** and C. **Béguin**: The biochemical synthesis, with the aid of emulsion from almonds, of a-ethyl-*b*-arabinoside.

ROME.

Royal Academy of the Lincei, February 7.—F. **Cavara** and A. **Chistoni**: Hybridisation of *Papaver somniferum* L. in relation to the morphine content of the opium. By hybridisation of the white and black varieties of *Papaver somniferum* L., it is possible to raise both the morphine content and the yield of the opium.—E. **Bompiani**: Projective invariants of contact between plane curves.—Harry **Levy**: Certain properties of the spaces for which Riemann's symbols with five indices are annulled.—Bruno **Finzi**: Vertical space motions in correspondence with uniform translations.—Francesco **Sbrana**: Dynamic effect of a fluid circulating round two cylinders with parallel axes.—Giorgio **Abetti**: The altitude of the solar chromosphere.—Enrico **Fermi**: The quantisation of the perfect monatomic gas.—A. **Pontremoli**: The duration of emission of monochromatic radiations and the mean life of the stationary states.—Pietro **Saccardi**: A colour reaction of the skin relative to the genesis of the melanins. The colour reactions obtained with *p*-phenylazoxycarbonamide confirm the epidermal origin of the cutaneous pigment and indicate that the ability to produce the colourless pro-pigment which generates melanin is a specific and autochthonous property of the Malpighian layer.—Ugo **De Castro**: Physico-biological conditions and determinism of Kottmann's reaction.—C. **Sibilia**: The action of certain enzymes of Fusarium. The actions produced by the amylase and pectinase of *F. echinosporum* and *F. fuliginosporum* are described.

VIENNA.

Academy of Sciences, March 4.—F. **Urbach** (Communication from the Radium Institute, No. 185): On luminescence and absorption particularly that of sylvine subjected to Becquerel radiation. Sylvine shows radio-luminescence and after Becquerel-radiation thermo-luminescence and phosphorescence.—J. **Zellner** and colleagues: Contributions to comparative vegetable chemistry (xii.). Chemistry of barks. Barks of privet, beech, elder, and alder have been examined. Phytosterin, ceryl alcohol, and several other substances have been found.—R. **Klapholz** and J. **Zellner**: Contributions to comparative vegetable chemistry; *Œnothera biennis*.—J. **Pollak** and E. **Gebauer-Fülnegg**: The action of chlorosulphonic acid on phenols.—E. **Gebauer-Fülnegg** and F. **Riesenfeld**: Studies on aryl-sulpho-chlorides.—K. **Federhofer**: The construction for the centre of curvature of plane curves.—L. **Waldmann**: The geological structure of the Moldau-Danube primitive rocks on the survey sheet Gmünd II.

March 11.—H. **Spandl** communicated his work, prepared in part with the assistance of the Academy, on the fauna of subterranean waters (Wien, Verlag Speläologisches Institut, 1926).

Official Publications Received.

Annuaire de l'Observatoire Royal de Belgique. 94me année, 1927. Par P. Stroobant. Pp. iii+192. (Bruxelles.)

Bureau of Science, Manila. Publication No. 10: Geology and Mineral Resources of the Philippine Islands. By Warren D. Smith. Pp. 559+89 plates. (Manila: Bureau of Printing.)

Instituts scientifiques de Buitenzorg. "'s Lands Plantentuin." Treubia: Recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 6, Livraison 3-4, Décembre 1925. Pp. 221-402+24 plates. 5f. Vol. 7, Livraison 2, Février 1926. Pp. 85. 2.50f. Vol. 8, Livraison 1-2, Janvier 1926. Pp. 196. 5f. (Batavia: Landsdrukkerij.)

The Optical Convention 1926. Catalogue of Optical and General Scientific Instruments. Pp. x+396. (London: 1 Lowther Gardens, S.W.7.)

State of Connecticut. Public Document No. 24: Forty-eighth Report of the Connecticut Agricultural Experiment Station, New Haven, Conn., for the Year 1924. Pp. ix+563+84T+xvi+39 plates. (New Haven, Conn.)

Union of South Africa. Report of the South African Museum for the Year ended 31st December 1925. Pp. ii+16. (Cape Town.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 561: Surface Water Supply of the United States, 1923. Part 1: North Atlantic Slope Drainage Basins. Pp. vi+294+3 plates. 35 cents. Bulletin 767: Geology and Coal Resources of the Gallup-Zuni Basin, New Mexico. By Julian D. Sears. Pp. v+53+17 plates. 50 cents. Bulletin 780-B: Geology of a part of Western Texas and Southeastern New Mexico, with Special Reference to Salt and Potash. By H. W. Hoots. (Contributions to Economic Geology, 1925, Part 1.) Pp. v+33-126+plates 3-17. Bulletin 780-C: Platinum near Centennial, Wyoming. By Frank L. Hess. (Contributions to Economic Geology, 1925, Part 1.) Pp. ii+127-135. Professional Paper 140-F: Correlation of the Basal Cretaceous Beds of the Southeastern States. By Wythe Cooke. (Shorter Contributions to General Geology, 1925.) Pp. 137-143+iii. (Washington, D.C.: Government Printing Office.)

The Carnegie United Kingdom Trust. Twelfth Annual Report (for the Year ending 31st December 1925) submitted by the Executive Committee to the Trustees on Friday, 12th March 1926. Pp. ii+109. (East Port, Dunfermline.)

Proceedings of the California Academy of Sciences. Fourth Series, Vol. 15, No. 1: Expedition to the Revillagigedo Islands, Mexico, in 1925. General Report. By G. Dallas Hanna. Pp. 113 (10 plates). (San Francisco, Cal.)

The North of Scotland College of Agriculture. Bulletin No. 30: Report on Grass Seed Mixtures, 1907–13. Second edition (enlarged) with some Observations regarding more Recent Trials. By Wm. M. Findlay. Pp. 75. (Aberdeen.)

Proceedings of the United States National Museum. Vol. 67, Art. 25: Foraminifera of the Genera Siphogenerina and Pavonina. By Joseph A. Cushman. Pp. 24+6 plates. Vol. 68, Art. 12: A Classification of the Toothlike Fossils, Conodonts, with Descriptions of American Devonian and Mississippian Species. By E. O. Ulrich and R. S. Bassler. Pp. 63+11 plates. (Washington, D.C.: Government Printing Office.)

Abstract-Bulletin of Nela Research Laboratory, Incandescent Lamp Department, of General Electric Company, Cleveland, Ohio. Vol. 1, No. 4, December 1925. Pp. x+523-746+8 plates. (Cleveland, Ohio.)

Classified List of Smithsonian Publications available for Distribution, March 15, 1925. Compiled by Helen Munroe. (Publication 2866.) Pp. v+30. (Washington, D.C.: Smithsonian Institution.)

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 26: Statistics of Land-Grant Colleges, Year ended June 30, 1924. By Walter J. Greenleaf. Pp. v+51. 10 cents. Bulletin, 1925, No. 33: Education Pays the State. By Merle A. Foster. Pp. 27. 5 cents. (Washington, D.C.: Government Printing Office.)

Diary of Societies.

SATURDAY, April 24.

Royal Sanitary Institute (at Guildhall, Hull), at 2.30.—H. Eldridge: The Economic Collection of Town Refuse.—W. Nicholson: The Present Position with regard to Smoke Prevention.

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 2.—J. G. Taylor: Coal and its Banded Constituents.—Discussion on Paper by F. J. Johnston on The Use of Breathing Apparatus in Mines.

Royal Institution of Great Britain, at 3.—Dr. W. T. Calman: The Shipworm (2).

MONDAY, April 26.

Royal Irish Academy (Dublin), at 4.15.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—Rev. Dr. H. U. W. Stanton: The Qur'an and its Doctrine of God.

Institute of Actuaries, at 5.—Notes concerning Some Practical Points that arise in the Valuation of Widows' Funds.

Institution of Structural Engineers (Students' Meeting) (at Abbey House, Westminster), at 6.—E. S. Andrews and others: Discussion on Theory *versus* Practice.

Institution of Electrical Engineers (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne) (Annual General Meeting), at 7.—B. A. Robinson: Modern Methods of Measurement (Lecture).

Institution of Electrical Engineers (South Midland Centre) (at Birmingham University), at 7.

Railway Club (at 65 Belgrave Road, S.W.), at 7.30.—L. Hiller: The Principles of Signalling.

Royal Society of Arts, at 8.—C. R. Peers: Ornament in Britain (Cantor Lectures) (2).

Royal Society of Medicine (Odontology Section), at 8.—W. Warwick James: Do Epithelial Odontomes increase in Size by their own Tension?—Dr. E. W. Fish: The Circulation of Lymph in Dentine, with some Observations on the Metabolism of this Tissue.

Royal Geographical Society (at Æolian Hall), at 8.30.—C. F. Rey: A Recent Journey to Gudru and Gojam (Abyssinia).

TUESDAY, April 27.

Royal Institution of Great Britain, at 5.15.—Prof. J. Barcroft: Organs of Multiple Function (3): Feathers.

Zoological Society of London, at 5.30.—The Secretary: Report on the Additions to the Society's Menagerie during the month of March, 1926.—Dr. J. Beattie: Exhibition of Radiographs of a young *Macacus rhesus*.—Prof. G. Elliot Smith: On the Brain of Cænolestes.—Dr. R. Broom: (*a*) On the Organ of Jacobson and some other Structures in the Nose of Cænolestes; (*b*) On a Nearly Complete Skeleton of a New Eosuchian Reptile.—J. W. Low: Contributions to the Development of the Pelvic Girdle. I. The Pelvic Girdle of *Menopoma alleghaniense* Harlan.—O. M. B. Bulman and W. F. Whittard: On Branchiosaurus and Allied Genera.

Institution of Civil Engineers, at 6.—H. R. Lupton: The Triple-Expansion Steam-Engine, as applied to the Pumping of Water; with Special Reference to the Plant at Lea Bridge.

Institute of Marine Engineers, at 6.30.—Refrigeration.

Royal Photographic Society of Great Britain (Kinematograph Group), at 7.—W. Vinten: International Standardisation of Kinematograph Standards.

Institution of Engineers and Shipbuilders in Scotland (at 39 Elmbank Crescent, Glasgow), at 7.30.

Institute of Metals (North-East Coast Local Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.—Annual General Meeting.

Royal Anthropological Institute, at 8.30.—C. W. Brown: Stone Implements from North-West Peru.

WEDNESDAY, April 28.

Newcomen Society for the Study of the History of Engineering and Technology (at 17 Fleet Street), at 5.30.—Comdr. A. D. Turnbull: The Stevens Family—Engineers and Inventors.

Radio Society of Great Britain (at Institution of Electrical Engineers), at 6.

Institution of Automobile Engineers (at Manchester College of Technology), at 7.30.—G. Rushton: The L.G.O.C. Methods of Omnibus Repair (Lecture).

Royal Microscopical Society (Industrial Applications of the Microscope Section), at 7.30.—R. and J. Beck, Ltd.: Exhibition of the Swan Photomicrographic Apparatus for Workshop Use and Radial Metallurgical Microscope.—H. Wrighton: Demonstration of the Preparation of Metallic Micro-Specimens.—At 8.—J. H. G. Monypenny: Some Micro-Structural Features of Modern Rustless Steels.

Royal Society of Arts, at 8.—J. Paterson: Horse Traction and Motor Traction.

British Psychological Society (Medical Section) (at Medical Society of London, 11 Chandos Street, W.1), at 8.30.—Dr. N. H. M. Burke: What is a Mental Illness?

THURSDAY, April 29.

British Science Guild (Annual Meeting) (at Mansion House), at 4.30.—Sir Richard Redmayne: The Future of the Coal Mining Industry.—Dr. E. F. Armstrong: Dyestuffs.—Capt. P. P. Eckersley: Broadcasting and Electrical Industry.

Royal Society, at 4.30.—C. H. Best, Dr. H. H. Dale, J. P. Hoet, and H. P. Marks: Oxidation and Storage of Glucose under the Action of Insulin.—C. H. Best, J. P. Hoet, and H. P. Marks: The Fate of the Sugar disappearing under the Action of Insulin.—J. P. Hoet and H. P. Marks: Observations on the Onset of Rigor mortis.—J. C. Mottram, G. M. Scott and Prof. S. Russ: On the Effects of Beta Rays from Radium upon Division and Growth of Cancer Cells.

Institute of Pathology and Research (St. Mary's Hospital, W.2), at 5.—Sir Almroth E. Wright: The General Outcome of Thirty-six Years' Work on Immunisation (Lecture).

London Mathematical Society (at Royal Astronomical Society), at 5.—Miss H. P. Hudson: Linear Dependence of the Schur Quadrics of a Cubic Surface.—Prof. G. N. Watson: On an Expansion Due to Abel.—B. A. Edwards: On Periodic (2-2) Correspondences between Two Planes.—C. G. F. James: On Scrolls in a Linear Congruence.—A. C. Dixon: The Solving Nuclei of Certain Integral Equations whose Nuclei are Homogeneous of Degree −1.—M. Hanna: Algebraicability of Integrals.—R. G. Cooke: Gibbs's Phenomenon in Fourier Bessel Series and Integrals.—J. Brill: On the Motion of an Ideal System referred to Natural Co-ordinates.—Prof. G. H. Hardy and J. E. Littlewood: (i) On the Strong Summability of a Fourier Series; (ii) On Parseval's Theorem.—S. Bochner and Prof. G. H. Hardy: Note on Two Theorems of N. Wiener.

Royal Institution of Great Britain, at 5.15.—Sir William Bragg: The Imperfect Crystallisation of Common Things (1).

Chemical Society, at 8.—Prof. W. E. S. Turner: Additive Relationships in the Properties of Glasses (Informal Lecture).

Child-Study Society (at Royal Sanitary Institute), at 5.30.—Annual Meeting.—At 6.—A. Farquharson: Homeland Survey for Children (Lecture).

Institution of Electrical Engineers, at 6.—B. S. Cohen, A. J. Aldridge, and W. West: The Frequency Characteristics of Telephone Systems, and Audio-Frequency Apparatus and their Measurement.

Illuminating Engineering Society (at Royal Society of Arts), at 7.—Dr. J. Kerr and others: Discussion on School Lighting (Modern Requirements and Recent Progress).

Institute of Chemistry Students' Association (London), at 8.—Open Evening.

FRIDAY, April 30.

Institution of Mechanical Engineers (Informal Meeting), at 7.—C. W. J. Taffs and others: Marine Oil-Engines in Practice.

Institution of Electrical Engineers (Scottish Centre) (at Y.M.C.A. Hall, Dundee), at 7.30.—Capt. P. P. Eckersley: The Past, Present, and Future Development of Wireless Telephony (Lecture).

Junior Institution of Engineers (at Royal United Service Institution), at 7.30.—Air Vice-Marshal Sir W. Sefton Brancker: Air Transport (Gustave Canet Memorial Lecture).

Royal Institution of Great Britain, at 9.—Dr. W. H. Eccles: Wireless in the Empire.

SATURDAY, May 1.

Royal Institution of Great Britain, at 3.—Dr. P. C. Buck: The Song Form in England as represented by Stanford.

Royal Institution of Great Britain, at 5.—Annual Meeting.

PUBLIC LECTURES.

MONDAY, April 26.

University College, at 5.30.—Prof. J. B. Collingwood: The Influence of Water on Vital Processes. (Succeeding Lectures on May 3, 10, 17, 24, and 31.)

TUESDAY, April 27.

King's College, at 4.30.—Prof. R. J. S. McDowall: The Integration of the Circulation. (Succeeding Lectures on May 4, 11, and 18.)

THURSDAY, April 29.

University College, at 5.—Prof. E. A. Gardner: History of Ancient Sculpture.

FRIDAY, April 30.

King's College, at 5.30.—Prof. J. Kay Jamieson: The Nature and Functions of the Fasciæ of the Human Body. (Succeeding Lectures on May 7 and 14.)

University College, at 5.30.—Sir Jagadis C. Bose: The Nervous Mechanism of Plants.

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The Source of Stellar Energy. By Prof. A S. Eddington, F.R.S. . . . . Supp. 25

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Coal Utilisation and Research.

THE Report of the Royal Commission on the Coal Industry, some aspects of which were presented by Prof. Henry Louis in an article in NATURE of March 20, is still under consideration and discussion. It is now generally understood that the report refuses to prescribe for the sick man any tonic or pill with the pleasing promise of a lightning cure, but insists on the necessity for a systematic application of the principles of economic hygiene to daily life as the primary essential to recovery. Even such labels as low-temperature carbonisation and electrification on the medicine bottles are not held to guarantee a cure. It is not that the spirit of the Commission has been cautious, conservative, or narrow. Its report is, indeed, quite remarkable for breadth of view, and for what appears to be a well-balanced consideration of the very numerous and varied factors which are operative in the problem presented. These characteristics can certainly be claimed for Chaps. iii. and iv. on utilisation of coal, and research, with which the present writer is more immediately concerned.

The position as regards actual and potential methods of consuming coal is admirably stated in Chap. iii., while Chap. iv. deals with the existing provision for research connected with coal, particularly 'organised' research, and with proposals for extending that provision. Under pre-treatment of coal, the adoption in the eighteenth century by British ironmasters of the use of coke in their blast furnaces is given the first place, initiating an industry which now employs 40,000,000*l.* of capital, and yields not only coke, but also tar, sulphate, benzole, and surplus gas. The position of the parallel carbonisation process, that of the gasworks, is indicated by the statement that the capital now engaged in it is 160,000,000*l.*—not very far short of the capital of the mining industry itself. Yet these two industries, in which coal is systematically treated before use, represent only some 37 million tons, while the coal consumed in its raw state amounts to 147 million tons, and the statement is made that, while for some purposes, such as large boiler plants, it is doubtful whether it would be economical to carbonise the coal before burning it, there is no doubt that a large proportion of the 147 million tons is consumed in a very wasteful manner.

The consideration of pollution of the atmosphere by smoke, the possibility of supplying oil from coal, and the position of low-temperature carbonisation, follow naturally with some reference to the use of pulverised solid fuel for firing furnaces and of the so-called colloidal fuel, that is, finely divided coal mixed with fuel oil. There is probably no one remedy for the smoke nuisance which would compare in importance with the use of some form of smokeless solid fuel in the domestic grate, and the interest in low-temperature carbonisation is stimulated by that idea. But the pronouncement of the Commission based upon a memorandum furnished by Dr. Lander is inevitably very guarded:

> "We have given close attention to the question of low-temperature carbonisation, but we can find no evidence that the system has yet been anywhere established on a commercial scale for a period sufficiently long to enable the claims that are made on its behalf to be fully tested."

It is not that carbonisation at a low temperature is a technically unrealisable process, since it is in essence a reversion to older practice. The difficulties are quantitative and commercial, and the problem is to overcome those difficulties in a fashion quite opposite to that adopted by the gas industry, which has developed by carbonising at high temperature and obtaining the maximum possible yield of gas—the carbonisation product which displays a greatly enhanced thermal efficiency in use with a correspondingly increased monetary value. Research on this subject is likely to have to go far back into the properties of coal itself, and the possible means of utilising and modifying such properties so as to arrive at a cheap and rapid process which will give the results required without incurring excessive costs in the installation of plant, and the working of the process itself. Encouragement is forthcoming from demands of different origin, since apart from all question of smoke abatement there is the national need for home supplies of liquid fuel, including motor spirit, and the desirability of finding some sort of use for low-grade coals, at present of no commercial value. If it were possible to subject to this process the bulk of the 147 million tons of coal now consumed in the raw state, the greater part at least of present British requirements of oil could be supplied from home sources, instead of being imported from abroad. Nor is the Commission pessimistic.

> ". . . the evidence we have taken has given us the impression that we may be within measurable distance of a solution of both the technical and commercial problems that arise. We recommend that the Government should give sympathetic consideration to any proposals of the Fuel Research Board for the further investigation of the process on a commercial scale."

There is no doubt that here a great difficulty presents itself. So far as concerns the scientific and technical research to which reference has been made above, into the properties of coal itself, the path is comparatively smooth, but the solution of what are grouped under the term of 'Commercial problems' is another matter. The Fuel Research Board has already gone so far as to undertake, without charge, the testing-out of low-temperature carbonisation plants on a commercial scale in order to obtain reliable information and to give it to those concerned. This is, as the writer can say from experience, no easy matter to carry through in such a way as to obtain trustworthy results, but it is practicable. The commercial interpretation of such results in a form to have any general application is, however, much more difficult, and the Fuel Research Board has so far held its hand at that stage. If, too, the financial backing of pioneering industrial adventures in this field is to be undertaken, it will have to be with eyes open to the very large costs which are only too easily incurred in such work without tangible results.

The Commission lays great stress on the co-ordination of coal-using industries, and its report should go far to counteract the mistaken ideas only too easily derived from the ill-balanced report of the Coal Conservation Committee issued in 1918. The Commission says:

> "It has been strongly impressed upon us as the outcome of our enquiries that it is an error to suppose that the only, or even the principal, object to be aimed at in this connexion is the most economical method of producing electricity. The object to be aimed at is the most economical and efficient way of utilising the energy embodied in the coal. The question is not co-ordination, as is often supposed, of two industries—coal and electricity—but of several—coal, electricity, gas, oil, chemical products, blast furnaces, coke ovens, etc. Two or more methods, dealing with two, three, or more of these, would be used simultaneously in combination, one feeding the other. The point of importance is, that no obstacles, whether of State regulation or industrial organisation, should be placed in the way of the development of such combinations in whatever manner engineering and chemical skill and the economic conditions may indicate as the most suitable."

Arising out of such considerations, the Commission "venture to suggest for consideration the formation of a Standing Conference composed perhaps of the Chairman and other representatives of those bodies we have mentioned," these being the Coal Commissioners (whose appointment is recommended elsewhere), the National Gas Council, and the Electricity Commissioners. Its primary task would be to ensure that while a healthy competition should be maintained where it was legitimate between these various interests, their energies should be developed in a manner complementary in the main to each other. Moreover, it is proposed that a survey, which from the nature of the case should be a continuous process undertaken by a body of a permanent character, should be made of the heat, light, and power requirements of the various industries of the country as a whole.

The Commission has concerned itself seriously with research into matters connected with coal as of primary importance, reviewing the present provision and suggesting developments. In all such schemes one outstanding point is often overlooked. If an industry is to reap the full value of research work done within it or on its behalf, it is essential that in the executive ranks of the industry itself, in its direction and management, there should be men willing and able to give effect to the results obtained and discoveries made. For this reason, the conversion of an industry from the empirical to the scientific is a gradual process, and is not to be done simply by the attachment of a research staff (with the formulation of a programme) to an industry which remains at heart unconvinced of the value of scientific work. The following sentence in the report is no doubt inspired by some such conviction: "It is also essential that the industry as a whole should become imbued with the spirit of science in order that it may utilise to the fullest extent the results of modern scientific developments." Another point of importance recognised is that the existing supply of research workers for the fuel industry is quite inadequate to meet such demands as are contemplated, and the recommendation is made "that the Colliery Owners' Research Association encourage the scientific training of students for the work of the Research Association, and for the survey, and that for these purposes it be authorised to provide scholarships and arrange with universities for suitable courses."

The field of research surveyed is a large one, including as it does occurrence and constitution of coal, coal winning, and coal utilisation, each with its subdivisions, hygiene and safety being given prominence in the coal-winning section. Work already in hand by the Fuel Research Board, the Safety in Mines Research Board, the Geological Survey, the Colliery Owners' Research Association, and the National Federation of Iron and Steel Manufacturers, is described, as also that carried out in conjunction with the University of Leeds by the Gas Investigation Committee of the Institution of Gas Engineers and by the National Benzole Association. It is noted that the Bergius process for the 'liquefaction' of coal and synthetic methods for the conversion of water-gas mixed with additional hydrogen into motor-spirit are receiving attention.

Then comes a section on the future of research work, which begins with an expression of opinion that the attitude of the British Coal Owners' Research Association (as indicated by Mr. Evan Williams, President of the Mining Association, in evidence) "indicates an insufficient appreciation of the importance of this question," and further emphatic statements, such as, "While research alone will not overcome the difficulties from which the Industry is now suffering [a qualification which the writer is glad to see made] we feel strongly that the steady and continuous investigation into all pertinent problems is essential if the industry is to prosper and to provide good wages and conditions for its workers"

Recommendation is made that the British Colliery Owners' Research Association be rapidly expanded, and that the managing council of the Association should be composed of representatives of the owners, managers, mining engineers, workers in the industry, the Mines Department, and the Department of Scientific and Industrial Research. A sum of 100,000*l.* should be provided for the establishment of a headquarters, a highly qualified director of research appointed, and such continuity as will attract the right men for the staff and render possible the obtaining of useful results in work which is necessarily slow, should be secured by guaranteeing an income averaging 40,000-50,000*l.* per annum for at least seven years. The funds are to be provided partly by the owners and partly by the Department of Scientific and Industrial Research, which is to take the initiative in organising and developing the Research Association. According to this scheme there would then be three large organisations, each dealing with one aspect of the coal problem: (*a*) The Colliery Owners' Research Association, expanded as indicated above, (*b*) The Safety in Mines Research Board, and (*c*) The Fuel Research Division of the Department of Scientific and Industrial Research. Co-ordination of the work is to be effected by the Department of Scientific and Industrial Research.

Such are the recommendations on research made by the Commission, and they have no doubt been carefully considered. It is plain that they place the Department of Scientific and Industrial Research in a highly responsible position at the centre of a highly elaborated organisation for dealing with a subject, that of research, which from its very nature is particularly difficult to organise. The maintaining together of sufficient elasticity in administration, insight and efficiency in the various directing bodies and their staffs, and goodwill in all concerned, will call for a very exceptional power of co-ordinating these estimable but not all-pervading qualities. The research programme is, however, so comprehensive as to give large scope for choice and initiative in its translation into active research, and even a fractional fulfilment of its promise would be a great national benefit. One note of warning may be sounded. If those engaged in the coal industry begin to make the assumption that research and pioneering work are essentially the concern of the nation or some association, and no longer that of the firm or the individual, many of the paths of progress, and quite probably the best, will be left unexplored.

JOHN W. COBB.

The Science of the Humanities.

A Dictionary of European Literature: Designed as a Companion to English Studies. By Laurie Magnus. Pp. xii+594. (London: George Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1926.) 25*s.* net.

"BEAUTY is Truth, Truth Beauty," wrote Keats, in passionate protest against all attempts to divorce them or to see in one the antipathy of the other. A similar recognition is growing that the oft-assumed antithesis between literature and science is a wanton and needless invention. The humanities of science has yet to be written, perhaps, though odd chapters have appeared from time to time; but the science of the humanities, if by such a phrase we may indicate the scientific treatment, in the widest sense of the word 'science,' of the material of the humanities, has for some time had its expositors.

The volume before us is a notable example of this larger view. It is, we believe, the first attempt yet made to apply, on such a restricted scale as the single volume, the comparative method to the literature of Europe. Prof. Saintsbury in his "Periods of European Literature" divided the subject into twelve "Periods" and marshalled a dozen specialists for the work, each of whom wrote a history of his chosen and allotted period. But if English studies are to be made as valuable a discipline as the Greek and Latin which they are displacing in the upper forms of the public schools and in the universities, there is need of a reference book covering the whole field in a single volume. Smith's "Dictionary of the Bible" and Lempriere's "Classical Dictionary" were written on these lines; and Mr. Laurie Magnus's "Dictionary of European Literature" takes a like direction and aim. It is, moreover, an application of scientific method to vast and scattered material.

Such a task is, of course, stupendous in no hackneyed sense of that word. The mere labour of reading, collecting, and collating the mass of material demands great industry and patience; but the crux of the difficulty comes when the digested and assimilated mass has to be turned into the flesh and blood of a live book. This is the ultimate test by which the work is to be judged. Have we here only another catalogue, exact and compendious, if you like, but still only a good catalogue of facts? Or are there spaciousness of view and single-mindedness of aim that give a unity to the whole? So far as we have been able to judge, the book stands this severe test.

The bulk of the articles consists of well-documented and up-to-date biographico-critical accounts of authors in all countries, with résumés of the literary history of each country under its own name. The author throughout combines an unflagging spirit with a calm and, so far as we have seen, an unbiassed critical judgment, and he is very often singularly happy in his mental picture of the writer whom he is treating. It would be pointless on the part of a reviewer to complain that too little space is given where he would have liked, or expected, more; and too much where his own taste and judgment would have led him to give less. Such personal disappointments are inevitable in all dictionaries and anthologies. It is perhaps only less pointless to say that, rarely here and there, we could have spared a little of the space devoted to the personal side of the particular author being treated, so as to have a fuller exposition of his work and message. This is, however, but by the way.

A valuable feature of the book is supplementary to these biographical and critical accounts of authors. In ordinary histories of English literature, or studies of single authors, names occur which are imperfectly understood. Thus, Renaissance, Reformation, Humanism, Romance, and similar terms cross several centuries and all countries. They are English names for European phenomena, and the English student is commonly very inadequately seized of their European meaning and value, and of the relation borne by the English part to the European whole. Within the circumscribed limits set by a single volume, Mr. Laurie Magnus has given a vivid and considerable elucidation of these generic phenomena. The reader may well turn immediately, for example, to the article on "Nature, Natural, Naturalism."

Another important set of topics is that of the classical writers. Tennyson is called Virgilian, and so on, and the metaphor is accepted easily, but the European vogue of Virgil, Cicero, Plato, and the rest cannot be grasped by students unless they consult special textbooks, usually in a foreign tongue. The "Dictionary of European Literature" endeavours to supply this information under the name of each classical writer. In such questions, too, as the influence of "Climate," the changing treatment of "Woman," the literary motive of "Death," there are similar articles bringing together information from various places and times, and fusing the constituent parts into a combined and intelligible whole.

The admirable preface to the book should be read to gather its purpose and aim. Its sub-title tells us the book is "designed as a companion to English studies." In our judgment it is, taking it all in all, a pleasant yet learned, stimulating yet judicious, companion, of fine but tempered enthusiasms. Its best virtue, perhaps, is that, as guide, it gives us zest to roam free and know more.

Pyrometric Methods.

(1) *Methods of Measuring Temperature.* By Dr. Ezer Griffiths. (Griffin's Scientific Text-Books.) Second edition, revised. Pp. xii + 203. (London: Charles Griffin and Co., Ltd., 1925.) 10*s.* 6*d.* net.

(2) *Pyrometers: Recent Developments in Pyrometric Appliances and Methods for Calibrating Temperature-Measuring Instruments; with Notes on Electric Furnaces.* By Dr. Ezer Griffiths. Pp. xi + 126. (London: Sir Isaac Pitman and Sons, Ltd., 1926.) 7*s.* 6*d.* net.

THERE are few physical investigations which do not call at some stage for a determination of temperature, although the conditions of the experiment and the accuracy demanded may vary within very wide limits. Hence the modern development of thermoelectric, resistance, optical, and radiation pyrometers, supplementing the mercury thermometer and referred to the gas thermometer as a standard, the latter instrument being too troublesome for practical routine determinations. So many industrial processes also now require accurate measurements of temperature that manufacturing works will be found to possess installations which would formerly have been seen only in a physical research laboratory. There is thus a need for scientific descriptions of the methods of measuring temperature, for the use of the industrialist as well as of the laboratory worker. The methods must be understood if they are to be employed to any purpose, and serious errors result from the use of instruments the principle of which is imperfectly realised.

(1) The first edition of Dr. Ezer Griffiths's book was welcomed as a valuable survey of modern methods of measurement of temperature. It has now been revised, mainly in the sections which deal with optical pyrometry. It gives a full account of most of the devices which find application in practice, and is not encumbered with descriptions of obsolete or untrustworthy methods. The diagrams showing the electrical circuits are very clear, and the directions for the use of the instruments are satisfactory. Since the practical metallurgist has to calibrate his instruments mainly by the determination of fixed points, a table of such points might well have been given, the particulars on this subject being rather scanty. Full details up to 450° are given, but for the higher temperatures fuller use might have been made of the recent work of the U.S. Bureau of Standards. References to the literature are given at the end of each chapter.

Experience in industrial pyrometry proves that two sources of error are most commonly found. Thermocouples undergo changes in course of use, so that the value of their indications does not remain constant. As a pyrometer which reads wrongly is worse than none at all, it is important that calibration should be repeated at intervals, and that the metallurgist should be fully acquainted with the methods of checking the accuracy of his instrument. The procedure is simple, and this work gives full particulars. The other error is less obvious. In a reheating furnace, for example, the temperature is never uniform throughout, and it is of the utmost importance that the pyrometer should be so placed that the temperature indicated should be that of the object being heated. This is often not the case, and one may sometimes see furnaces in which the temperature of the objects heated obviously differs by 100° or more from that shown by the pyrometer, owing to the placing of the latter. In a book of this kind, a chapter on the subject of the placing of pyrometers in the spaces being heated would have been useful. The accuracy of the eye of a trained man, such as a steel hardener, is remarkable, and it is to be hoped that the more general use of pyrometers will not lead to a complete abandonment of the practice of visual determination of temperature, this being often a valuable control of the indications of a pyrometer.

(2) Dr. Griffiths's second book contains a very brief outline of the most modern types of pyrometer, together with some special applications to difficult practical problems, such as the determination of the temperature of rapidly moving parts and of the windings of transformers. It will be found useful in industrial works, the descriptions being clear and to the point. A short chapter is devoted to furnaces for high temperatures. The account of the Ajax high-frequency induction furnace does not quite accurately describe the latest type, but it is well that this very useful method of attaining high temperatures should be mentioned. The only optical pyrometers described are those of the disappearing filament type, the author rightly regarding this as by far the most simple and trustworthy.

C. H. D.

The Earliest Herbal written in England.

The Herbal of Apuleius Barbarus, from the early Twelfth-century Manuscript formerly in the Abbey of Bury St. Edmunds (MS. Bodley 130). Described by Dr. Robert T. Gunther. Dedicated and presented to the President and Members of the Roxburghe Club by Edward George Spencer-Churchill, 1925.

BOTANISTS and palæographers are greatly indebted to the Roxburghe Club, and especially to Capt. E. G. Spencer-Churchill, for the magnificent facsimile copy of the "Herbal of Apuleius Barbarus," which has been reproduced photographically from the original manuscript in the Bodleian by the Clarendon Press.

The value of this publication is not only greatly enhanced, but is also rendered of extraordinary interest, since Dr. R. T. Gunther has compiled a very valuable introduction in which the history of the "Herbal" and its relation to other herbals is fully discussed. The appendices are of equal value, as in Appendix I. the herbs described in the Bodley MS. are set out in order, with notes on the text and identifications of the plants described and figured, so far as this has been found to be possible. This difficult work of identification of figures, often copied from earlier works, has been done partly by the late Mr. James Britten, whose name is an assurance of the meticulous care with which the work has been done, and after his death by Dr. A. B. Rendle.

The interest of the MS. Codex lies in the fact that it includes the earliest herbal believed to have been written and illustrated in England, the date being about A.D. 1100; also that it once belonged to the Abbey of Bury St. Edmunds. The history of the Codex and its wanderings is given, in the early pages of the introduction, up to the time that it was presented to the Bodleian some 220 years ago. But for Dr. Gunther having consulted the manuscript in an endeavour to trace the origin of a drawing of the "Saxifrage of the Antients," copied from an old manuscript by John Goodyer, the Codex might still have reposed, receiving scant attention, in Bodley's library.

The illustrations amply justify the reproduction of the manuscript in facsimile. Most are based on traditional 'Dioscoridean' drawings of remote antiquity. The most complete series of such early plant drawings are to be found in the manuscript illustrated about A.D. 512 by Greek artists as a wedding gift for Julia Anicia, daughter of Flavius Anicius Olybrius, Emperor of the West. Some of these with their descriptions were no doubt derived from Crateuas' paintings of plants executed in the first century B.C., combined with the text of the "Materia medica" of Dioscorides. The paintings illustrating these early herbals appear to have been copied one from another without reference, except in rare cases, to the plants, with the result, as may be seen in Apuleius's "Herbal," that many have become so conventionalised as to be scarcely recognisable.

It is much to be regretted that certain chapters are missing from this "Herbal," in particular those describing the mandrake and the *Herba Basiliske*, but this defect has been remedied by including in the introduction a reproduction in colour of the mandrake from MS. Ashmole 1431, and descriptions of both plants in English from Cockayne's translation of the Anglo-Saxon "Apuleius." Two very interesting plates of German figures from an Italian MS. in the Library of Trinity College, Cambridge, illustrating the mandrake, rosemary for sore eyes, devils being cast out by a herb, and *Herba Delfion* or (?) delphinium, with the flowers transformed into dolphins or fishes, conclude Dr. Gunther's valuable introduction.

The value of the appendix lies in the citation of the titles of the chapters and the modern botanical names, reprinted from Cockayne's edition of an Anglo-Saxon version of the "Herbal," the Dioscoridean and Theophrastan synonyms, notes on the colours of the roots, leaves and flowers in the illustrations in the MS., and suggestions as to the correct identification of the figures. These, as might be expected when it is possible to suggest determinations, are often entirely different from the names given in the Anglo-Saxon version. The figures are all of interest, but some, such as *Cotyledon umbilicus*, *Herba Narcissus* and *Herba Hipperis*, show how much has been lost by repeated copying.

In the second appendix a useful table is given showing the variation in the numerical order of the plants described in the Ashmole 1431, Anglo-Saxon MS. V., and the Bodley MS. 130, here reproduced, and the printed edition of the "Herbarium of Apuleius" of 1526. A complete index concludes this very interesting volume.

Our Bookshelf.

Chemical Synonyms and Trade Names: a Dictionary and Commercial Handbook. By William Gardner. Second edition, much enlarged. Pp. vi + 271 + 56. (A companion volume to the first edition, containing the additional Synonyms in the second edition, is also issued. Pp. 56. 7*s.* 6*d.* net.) (London: Crosby Lockwood and Son, 1925.) 30*s.* net.

THE number of entries in this dictionary is now between 16,000 and 17,000, several thousands being new to the second edition. The added material has, for an obvious reason, been placed at the end of the book with a separate pagination, but owners of the first edition may purchase it in the form of a companion volume. From the outset it was clear that this publication would meet a want, and we know of no book which covers the same ground so usefully and, withal, so accurately. Not only will it appeal to those who traffic in chemicals and their raw materials, but the general reader will also find in it much to interest him, *e.g.* the composition of many commodities that he uses in daily life: the ingredients of soaps, water-softeners, perfumes, dyes, drugs, disinfectants, and so forth.

The expert, knowing the extreme difficulty of making such a dictionary all-inclusive, will not expect to find everything he seeks, and he may be disappointed not to find more information concerning the nature of proprietary articles; but he will be interested to learn that the excellent disinfectant which has usurped the name of one of England's most famous poets, owes its efficacy to the presence in it of sodium hypochlorite. It is common knowledge that chemists can no more answer the question: What is a chemical? than the related one: What is a chemist? Nevertheless, we believe that most of them would be surprised to find in a dictionary of chemical synonyms such names as briquettes, hop-flour, molasses, gin, and Apollinaris!

Contributions to the Ethnology of the Kwakiutl. By Franz Boas. (Columbia University Contributions to Anthropology, Vol. 3.) Pp. vi+357. (New York: Columbia University Press; London: Oxford University Press, 1925.) 21*s.* net.

THIS volume consists of Kwakiutl texts with translations for which the material was obtained from a half-blood Indian of Fort Rupert, British Columbia, who speaks Kwakiutl as his native language and has been trained in phonetic writing by Prof. Boas himself. It is a continuation of Vol. 35 of the annual report of the American Bureau of Ethnology. The greater part of the texts deal with the social organisation of the people, and they have this advantage for the student, that they deal with concrete examples, described in minute detail, of such social elements as inheritance and succession, naming, marriage, and the like.

The section which is particularly welcome, however, is the transcript of sixty-five dreams These are of interest from the point of view of both the psychologist and the student of religion A number of the dreams are of an ordinary type merely reproducing everyday activities. Of the others, some describe relations with the dead. In one a son was told by his father of his discomforts in the spirit world, and on waking he burned two pairs of blankets and food for the soul of his father. Two dreams deal with the Shaman's crystal: in one the dreamer finds a crystal in the stomach of a seal; in the second a crystal is forced into the dreamer's body by a gull which had spat it out. A man well known as a 'true' dreamer anticipated the news of the death in England of a former missionary. It is stated that this dream was told to the writer the morning after its occurrence, and the letter containing the news of the death not received until some time after. The familiar nightmare of falling from a height is recorded. A number of the dreams are interpreted as foretelling epidemics and death.

The Anglo-Saxon Cemetery at Girton College, Cambridge: a Report based on the MS. Notes of the Excavations made by the late F. J. H. Jenkinson, M.A. By E. J. Hollingworth and M. M. O'Reilly. Pp. vii+38+12 plates. (Cambridge: At the University Press, 1925.) 4*s* net.

THE Anglo-Saxon Cemetery at Girton College, which lies a few yards north of the Roman road from Cambridge to Godmanchester, was discovered in 1881 in the course of building operations. About 150 cremation interments and 75 to 80 skeletons were then brought to light. Further discoveries were made in 1886; but while the authors of the book have been able to avail themselves of the careful notes of the late Mr. Jenkinson from the earlier excavations, the conditions under which the later examination was made precluded anything like a detailed record. The authors have performed a pious duty to their College and a real service to archæology in working up the material provided by these notes and by the actual objects, some on loan from Girton College, which are now in the University Museum of Archæology and Ethnology at Cambridge The cemetery was evidently of considerable size, and presents several points of considerable interest. Cremation and inhumation were practised contemporaneously throughout the whole period of pagan Saxon occupation. A fragment of pottery suggests that the site may have been occupied so early as the Middle Bronze age, and two Roman cremated burials were also found.

Die Schalltechnik. Von Dr. Richard Berger. (Sammlung Vieweg, Heft 83.) Pp. iv+115. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1926.) 8 gold marks.

IT is strange that in text-books dealing with the practical applications of our knowledge of sound, each author considers it necessary to employ a special vocabulary to describe sound phenomena, and each author employs a different one. This monograph provides an illustration, for the first part of it is devoted to well-known theories of the propagation and production of the various types of waves, which are described in a new nomenclature. Theory is then somewhat abruptly set aside and a description of practical technique is commenced. This part of the book is much more helpful, for it describes work carried out in Germany which had for its object the prevention of noise with moving machinery, and the insulation of other portions of a building from such noise. The work of Sabine and Watson on the acoustics of buildings is touched upon, but the list of absorption coefficients given is not up-to-date. Sound-signalling, including the effect of wind, sound-ranging and direction finding are also described, the work of the Danish and German artillery sections providing most of the material. The final section deals with the work of Miller in the United States on the analysis of sounds produced by musical instruments and by the human voice.

Volumetric Analysis: with a Chapter on Simple Gravimetric Determinations By A. J. Berry. (Cambridge Physical Series) Third edition. Pp. vii + 151. (Cambridge: At the University Press, 1925.) 9*s.* net.

THIS work was first published in 1915, and the fact that it has reached a third edition, in spite of the appearance of a large number of books covering the same ground, is good testimony to its popularity and value. The treatment is clear and scientific, an excellent feature being the judicious interweaving of explanatory theoretical matter with the practical instructions. In the recent edition is included a new chapter on simple gravimetric determinations which contains much useful advice to the young student concerning general principles. The author is under no illusion that analytical chemistry can be taught exclusively from books: it is a craft as much as a science, and in the learning of it, practice in doing must take precedence over theoretical explanations, important as these are at the proper stage. It is a pleasure to note the author's strong recommendation of Masson's method for standardising hydrochloric acid with Iceland spar, which is not only very simple but also, as he states, yields results of extreme accuracy.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Transmutation of Elements.

IN a letter to NATURE of January 30, 1926, Dr. Davies and Prof. Frank Horton give some considerations about the transmutation of mercury and lead which agree completely with those given by me in a lecture delivered in Amsterdam on January 29, 1926.

I considered the two possibilities of transmutation by absorption of electrons or by disruption of the atomic nucleus. Since I thought the latter more probable in the cases mentioned above, I laid most stress upon this possibility and gave the following considerations :

Aston found the atomic weights of the isotopes of mercury to be 202, 209, 199, 198, 201, 204. Assuming that, for example, the isotope 201 suffers a transmutation into gold by disruption of the nucleus, this process can be indicated by the following equations :

$$\begin{array}{rl} & \mathrm{Hg} - \alpha - \theta = \mathrm{Au} \\ \text{atomic weight} & 201 - 4 \quad = 197 \\ \text{atomic number} & 80 - 2 + 1 = 79 \end{array} \qquad . \quad . \quad (1)$$

or

$$\begin{array}{l} \mathrm{Hg} - 4\mathrm{H} - 3\theta = \mathrm{Au} \\ 201 - 4 \qquad\quad = 197 \\ 80 - 4 \ \ + 3 = 79 \end{array} \qquad . \quad . \quad . \quad (2)$$

In the case of the transmutation of lead into mercury, the inactive isotopes having the atomic weights 206, 208 and 210, we may assume, for example, that the isotope 206 suffers a transmutation giving an isotope of mercury :

$$\begin{array}{l} \mathrm{Pb} - \alpha = \mathrm{Hg} \\ 206 - 4 = 202 \\ 82 - 2 = 80 \end{array} \qquad . \quad . \quad . \quad (3)$$

But we may also assume that the other isotopes 208 and 210 undergo a transmutation. In that case we obtain :

$$\begin{array}{l} \mathrm{Pb} - 2\alpha - 2\theta = \mathrm{Hg} \\ 208 - 8 \qquad\quad = 200 \\ 82 - 4 \ + \ 2 = 80 \end{array} \qquad . \quad . \quad . \quad (4)$$

and

$$\begin{array}{l} \mathrm{Pb} - 2\alpha - 2\theta = \mathrm{Hg} \\ 210 - 8 \qquad\quad = 202 \\ 82 - 4 \ + \ 2 = 80 \end{array} \qquad . \quad . \quad . \quad (5)$$

In the case of the transmutation of lead into thallium we can assume, for example, the following process :

$$\begin{array}{l} \mathrm{Pb} - \alpha - \theta = \mathrm{Tl} \\ 208 - 4 \qquad = 204 \\ 82 - 2 + 1 = 81 \end{array} \qquad . \quad . \quad . \quad (6)$$

We see that of the different transmutation possibilities, (3) is most simple Moreover, I suspected this process could be expected first, as lead is the end-product of the spontaneous radioactive transformations.

In connexion with these considerations I pointed out that the best method of learning the nature of the transmutation is to examine spectroscopically whether the process is accompanied by the formation of helium or hydrogen, and to determine the atomic weight of the heavier products.

With a new apparatus which promised to enable us to study the problem successfully, my co-worker Dr. Karssen and I carried out a series of new experiments. While using the old quartz-lead lamp, negative results were obtained only if the current strength was lower than 15 amperes, but now, with our new lamps of somewhat different dimensions, spectroscopically negative results were found even using ± 60 amperes. The lamp showed distinctly different properties in burning and sparking. This proves that the phenomena taking place in the quartz-lead lamp depend on influences unknown until now, so that the transmutation in the quartz-lead lamp is not so easy to reproduce as we expected.

In connexion with this subject we are studying now the quartz-lead lamp more closely, and in the meantime we are applying our second sparking method, which we intend to extend to still higher voltage and higher current-densities.

Though we have already secured quantitative data, we prefer to publish the results later. A. SMITS.

Laboratory of General and Inorganic Chemistry,
University of Amsterdam,
April 3.

Potassium and the Heat of the Earth.

IT has been widely recognised that the disintegration of the uranium and thorium in rocks has exerted a profound and probably controlling influence on the earth's thermal history. Hitherto, however, it has not been realised that potassium as an emitter of radiothermal energy is in the aggregate of the same order of importance as uranium or thorium. This surprising result has emerged in the course of a joint inquiry into the geological significance of the radioactivity of potassium and rubidium. The latter element is negligible geologically on account of its extreme rarity, despite the fact that its total activity is greater than that of an equal amount of potassium. Nevertheless, we have included rubidium in our discussion, since measurements of the activity of potassium have usually been compared with those obtained with rubidium, and our preliminary estimate of the amount of heat generated by the potassium in rocks depends on that comparison.

The β-rays emitted by rubidium are fairly homogeneous ; their velocity has been estimated from experiments on their deflexion in a magnetic field (Bergwitz), and by comparison of their absorption coefficient with those of radioactive rays of known velocity (Hahn). These experiments point to a velocity of 0·60 *c*, the corresponding kinetic energy of a β-ray from rubidium being $2{\cdot}04 \times 10^{-7}$ ergs. In the case of potassium, Hahn has concluded that the average velocity of the β-rays cannot differ much from 0·90 *c*. We probably make adequate allowance for the heterogeneous nature of the potassium rays by assuming for them the value $\mu = 20$ cm.$^{-1}$ aluminium. Using this result in conjunction with Lenard's curves of absorption of β-rays of different velocities, we obtain for the average velocity of the potassium rays the value 0·85 *c*, a result in substantial agreement with that of Hahn. The average kinetic energy of a β-ray from potassium is thus $7{\cdot}30 \times 10^{-7}$ ergs.

We next require the half-periods or the disintegration constants of rubidium and potassium. Hahn and Rothenbach compared the activity of the β-rays from rubidium with that of the β-rays from UX$_1$, and thus found for rubidium a half-value period of $0{\cdot}7 \times 10^{11}$ years, this result being uncorrected for the different values of the number of ions per cm. and the Loschmidt numbers (per gm.) for the substances compared. Applying the necessary corrections, we find $T_{\mathrm{Rb}} = 1{\cdot}4 \times 10^{11}$ years. Hoffmann also has compared the activity of rubidium and of potassium with that of uranium, using two different methods, and he concludes that his results are in agreement with that of Hahn and Rothenbach, though slightly lower. Correcting Hoffmann's results to take account of the absorption of the rays in his apparatus and in the active film employed, we find $T_{Rb} = 1 \cdot 1 \times 10^{11}$ years from the results of the first method, and $T_{Rb} =$ *ca.* $0 \cdot 8 \times 10^{11}$ years from those of the second. The half-value period of rubidium cannot therefore differ much from 10^{11} years, and we have adopted this value as the most probable approximation.

The data for potassium are not yet established with the same degree of accuracy. Estimates of the total activity of rubidium relative to that of an equal weight of potassium vary between 7·0 and 1·4, indicating that the half-period of potassium lies between 50 and 11 times that of rubidium. Fortunately, Hoffmann's delicate measurements (referred to above) reduce the range of these extremes very considerably. His two methods gave results indicating that the half-period of potassium is between 14 and 22 times that of rubidium, the lower value being of superior reliability. Taking all the available data into consideration, we conclude that a ratio of about 15 appears to be the most representative in our present state of knowledge. This gives for the half-value period of potassium, T_K = about 15×10^{11} years.

We are now in a position to calculate the annual heat production from one gram of potassium and rubidium respectively, and consequently to calculate further the annual heat production due to the presence of these elements in one gram of any rock of known composition. The calculations are embodied in the accompanying table, and, for comparison, the results for average igneous rock are given, and the annual heat productions due to uranium and thorium (together with their disintegration products) per gram of rock are included.

Element.	Uranium	Thorium	Potassium	Rubidium
Loschmidt Number, N, atoms per gram .	.	.	$15 \cdot 5 \times 10^{21}$	$7 \cdot 09 \times 10^{21}$
Half-value Period, T, in years . . .	.		15×10^{11}	1×10^{11}
Disintegration Constant, λ, year^{-1} .	.	.	$4 \cdot 6 \times 10^{-13}$	69×10^{-13}
Annual No. of Atoms disintegrating per gram $n = \lambda N$			$7 \cdot 1 \times 10^{9}$	49×10^{9}
Kinetic Energy, E ergs per β-ray	..	..	$7 \cdot 30 \times 10^{-7}$	$2 \cdot 04 \times 10^{-7}$
Energy liberated per gram per year $nE/(4 \cdot 19 \times 10^{7})$ cal	(7900×10^{-4})	(2300×10^{-4})	$1 \cdot 24 \times 10^{-4}$	$2 \cdot 38 \times 10^{-5}$
Contents in grm per gram of average igneous rock	6×10^{-6}	15×10^{-6}	$26{,}000 \times 10^{-6}$	$m \times 10^{-6}$
Heat generated in cal. per gm of average rock per year	$4 \cdot 74 \times 10^{-6}$	$3 \cdot 45 \times 10^{-6}$	$3 \cdot 22 \times 10^{-6}$	$2 \cdot 38\ m \times 10^{-11}$

The geological consequences of the radioactivity of potassium are clearly of great importance, for the heat generated within the rocks is now found to be considerably greater than the amounts hitherto calculated from uranium and thorium alone. For average granite the heat annually generated per c.c. becomes 40×10^{-6} calories instead of 30×10^{-6} calories. For average plateau-basalt the corresponding new estimate is 12×10^{-6} cal. per year instead of 9×10^{-6} cal.

A rough estimate of the mean thickness of the granitic layer of the continents can be arrived at by equating the amount of heat escaping at the surface with the heat generated within the granitic layer. Taking a column of unit cross-section, the heat lost per annum averages 60 calories, and evidently this can be entirely supplied by 15 km. of average granite. Seismic data have until recently been held to indicate about 30 km. for the average thickness of the granitic layer of Eurasia (Oldham, Wiechert, Angenheister, Gutenberg, and others). Within the last few months, however, Stoneley has shown that dispersion affects the validity of estimates such as that of Gutenberg, and Jeffreys has found that the necessary corrections reduce the estimates of thickness to 15 km. Recognition of the effects due to potassium thus brings about a satisfactory accordance which otherwise could never have been achieved.

Beneath the granitic layer, heat is supposed to accumulate until the latent heat of basaltic material is supplied, and fusion takes place. The average time required for the accumulation of 270 cal. per c.c. of basaltic material now becomes 22·5 million years instead of 30 million years. These figures are, of course, highly speculative, and are introduced merely to illustrate the geological significance of potassium.

Our investigation was partly stimulated by the possibility that the radioactivity of potassium might have been of considerably greater effect in early geological time than it is now, and so have led to the extensive intrusions of granite that everywhere characterised the earlier pre-Cambrian eras. It is, however, not yet possible to draw any such conclusion; nor will it become possible, unless the activity is found by future investigations to be confined to a still undiscovered isotope which has been appreciably wearing out through geological time.

ARTHUR HOLMES,
The University, Durham.

ROBERT W. LAWSON,
The University, Sheffield.

April 5.

Use of Thermit in Ice-Breaking.

THE remarkable results obtained by Dr. H. T. Barnes and his co-workers at Oil City and Franklin in alleviating disaster owing to ice-jams in twenty-four miles of the Allegheny River have received widespread attention.

The effectiveness of the undertaking is guaranteed by competent engineers on the spot who watched all the operations, and the success of the thermit treatment was even greater than Dr. Barnes himself had anticipated.

The physical aspect of the action of thermit on ice is an interesting one which deserves consideration altogether apart from the question of ice engineering. One pound of thermit when ignited gives 1500 British thermal units, less than a pound of coal. Hence, if a container of 100 lb. is ignited, 150,000 B.T.U. is released, and, as it takes eighty of these units to melt a pound of ice, we see at once by division that a little less than one ton of ice (about 1900 lb.) will be melted; or, a ton of thermit will melt under favourable conditions 95 short tons of ice.

This in itself is an important result, because, if 95 tons of ice are melted at the right time in the right place, a very considerable effect may be produced where there is a current of water to push the ice down a river. The above consideration is of course at once grasped by every engineer and physicist.

The remarkable effects which appear to be produced by the action of thermit packed in solid ice is clearly not to be referred mainly to the above. Thermit (iron oxide and powdered aluminium) ignited in the open attains rapidly a temperature of about 3000° C., and there is then nothing in the way of an explosion.

When, however, thermit is ignited, *closely surrounded by solid ice*, the photographs obtained by Dr. Barnes indicate a highly explosive action quite different from that in the open. Here we have to deal perhaps with the results due to an *impulse* rather than with either heat or with pressure over a considerable interval of time. Those who have tested a new gut fishing-cast and have proved that it will stand a steady strain of six pounds weight are familiar with the experience that it may snap when they strike quickly at a half-pound trout. A tap on a pin may fracture a block of ice which has withstood a blow from an axe. A small hot flame will fracture a large plate of glass. These are examples of impulsive effects, quick action being essential.

Now let us return to the container of 100 lb. of thermit yielding 150,000 B.T.U., and let us further recollect that each B.T.U. can do work amounting to 778 foot-pounds. On multiplying these numbers together we arrive at 117,000,000 foot-pounds or about 60,000 foot-tons, sufficient to raise a 10,000-ton ship vertically six feet against gravity. Imagine now a vessel weighing 10,000 tons dropped six feet on to a river seriously blocked with ice. There would be smashing and cracking of the ice in all directions, and, with water pressure behind them, blocks of ice might well be released. It is further desirable to contemplate not only the explosive action of the thermit, but also the effect of the radiation, from a high temperature source, which may pass for a considerable distance through the ice, causing changes which recall Tyndall's famous experiment on 'flowers of ice.' Much of the water in a river is above the freezing point, and if this is allowed to seep into the enlarged surface of partially disintegrated ice, melting is accelerated. It appears to be conceded by engineers that thermit is better than black powder, and black powder than dynamite, for ice-removal.

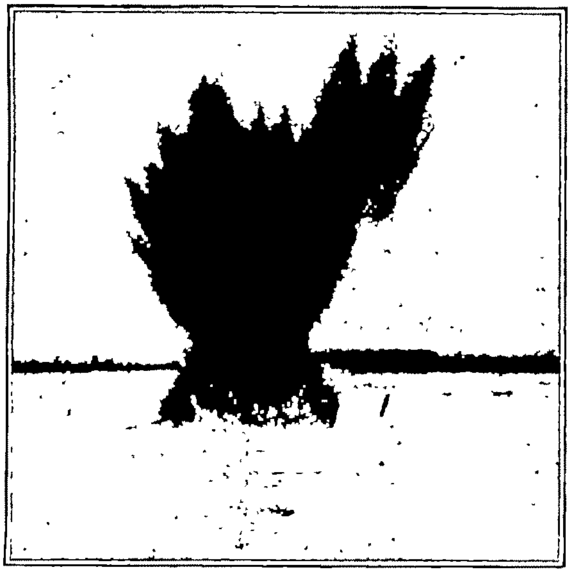

Fig. 1.—Ice exploding due to a charge of 90 lb of thermit in the River St. Lawrence at Chimney Island, below Ogdensburg, N.Y. The mine was placed four feet down in slush-ice underhanging to a depth of eight feet the solid surface ice two feet thick. The bright flames forty-five feet high give a reversed image in the photograph, and, below, the disrupted ice is seen raised six feet. (Photo by W. A. Connolly, Morrisburg, Ontario.)

The interesting question is to what extent we have to attribute the effects of thermit to (*a*) heating, (*b*) explosions, (*c*) high temperature radiation. It is on this account, and for the further reason that there is an actual possibility of disintegration of ice into atomic gases, that the experiments on thermit are of such a highly interesting character to the physicist no less than to the engineer. There is, of course, no suggestion that the laws of conservation of energy are not obeyed. Yet it is clear that the investigation of the action of thermit presents a problem of great importance which requires money, time, and skilful research work in the laboratory as well as in the field.

A. S. Eve.

McGill University,
Montreal.

The Problem of X-ray Line Intensities.

Referring to the experiments mentioned by the present writer in recent issues of Nature (January 30, p. 153; March 27, p. 448), and other work not yet published, we have had on several films and on one plate lines of wave-lengths 1·040 and *1·038*[1] respectively. It seemed impossible to regard these lines as being due to mercury, since either the Hg$L\alpha_1$ or the Hg$L\beta_1$ line has not been present. The films and plate represented good photography, and the exposures were over a wide range, so that these lines fell about midway.

The problem is to account for these lines, which will be referred to collectively as the '1·040 line.' This line does not always occur, even faintly, on changing the substance on the copper anticathode, but it does appear when the substances are such that they might contain an element of atomic number 87 (see first citation above).

We have had lines *1·038* and *0·930* on one plate, and 1·040 on films as stated above; these occurring when the presence of bromine seemed out of the question, and the *0·930* line has not yet appeared except once and then with the *1·038* line. These two lines were obtained under the following conditions: Commercial potassium phosphate (monobasic) melted on the anticathode. Optical spectrum revealed the presence of calcium only as an impurity. X-ray exposure 12 hours. Voltage 60,000. Current 5 to 8 milliamperes. Shearer tube with water-cooled parts. Müller spectrograph. Plate distance 80·04 cm. Slit 0·1 mm. Angle of oscillation 5°-17°. Oil backing pump and mercury pump used. All lines clear and well defined. Plate clear with no fogging except along one side. The bromine absorption edge sharp and almost completely obscured along part of its length by side fogging (see below).

Some further incidental particulars are: The *0·930* line was weak compared with the *1·038* line. Three copper-anticathode lines were present, counting the α_2 and α_1 lines as one, which were resolved. The characteristic copper lines were very strong and had so-called satellites on the longer wave-length side, which were probably due to an imperfection in the rocksalt crystal. The only other lines were weak lines *1·436* and *1·242*, probably due to the zinc and mercury, the former from the brass of the apparatus and the latter from the mercury used in exhaustion—as might be expected with a 12-hour run.

It is to be noted that the Rb$K\alpha_2$ line has a wave-length of 0·928. Experimental error in the measurements cited above 0·003. If *other* experiments had given evidence of bromine being present in the tube, or in the compounds used, the above line could be expected, for the Br$K\alpha_1$ line is 1·0377.

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[1] Accurate micrometer measurements have been made in those cases where the values are given in italics, all of which are in Ångstrom units; and the bromine absorption edge has served as a check in measuring the region between it and the Cu$K\beta_1$ line.

It has occurred to the writer that whenever a very weak radiation, corresponding in wave-length closely with that of a BrK line—perhaps an α_2 incident radiation—falls on a film or plate, the bromine in the emulsion, or the emulsion in conjunction with the bromine, is stimulated into greater photographic sensitivity and a comparatively strong line appears, especially under the conditions of our experiments, *e g.* long exposure.

This hypothesis would seem to give a satisfactory explanation of the appearance of the '1·040 line.'

As an incidental feature, on the plate we had a slight fogging along one side or edge which partly obliterated the *0 930* line, showing that slight darkening may obscure a weak line, as was stated by the writer in connexion with the suspected $87L\beta_1$ line (see citations above). The stronger lines were not, however, reduced in intensity by the slight side-fogging.

In conclusion, it will be seen that if the above view is in the main true, then the following radiations, in terms of lines, though very weak, would give rise to more or less strong lines. Hg$L\beta_2$ 1·0375, As$K\beta_2$ 1·038, ($87L\alpha_2$ 1·039), (Br$K\alpha_1$ 1·0377), Tl$L\beta_4$ 1·0371; Rb$K\alpha_2$ 0·9277, (Br$K\beta_1$ 0·931), Cd second order $K\beta_2$ 0·928 The brackets indicate complete exclusion from consideration or doubt in respect of stimulation Some of these radiations can be eliminated by control experiments, so that it may be possible to find out the element which is operative if the effect is not due to a complex of lines The optical spectrum would be helpful here as a guide, but in our case it has not revealed an element corresponding with either of the two lines in question, as might be expected.

It seems important that the whole bromine X-ray spectrum (K) should be determined if there is anything in the idea here advanced

Perhaps one of your readers would kindly offer a better explanation of the matter than here attempted, bearing in mind that there is a tendency for all the lines in question to be shifted perceptibly towards the longer wave-length side, and on this account our line 1·032 (*loc. cit*) may be the same as the *1·038* line.

F. H. Loring.

Relative Intensities of the D_1 D_2 Lines of Sodium in Comets and in Low Pressure Laboratory Sources.

Sodium D lines of emission were identified beyond any possible doubt in the heads of the following comets: Wells, (1882*a*), Great Comet, 1882 (1882*b*); 1910*a*; Halley's Comet (1910*c*); and Brooks' Comet, (1911*c*) The appearance of these lines has always been of temporary character at perihelion. The spectra of the first three comets were observed either visually or by means of a prismatic camera, so that the only reliable determinations of wave-lengths are furnished for the comets Halley and Brooks. The spectrum of the former was taken by E. C Slipher (*Lowell Observatory Bull.* 52) with the slit spectrograph of Lowell Observatory, and that of the latter by W. H. Wright (*Lick Observatory Bull* 209) with the Lick refractor.

Slipher gives for the sodium lines only one wave-length, 5891·9, which is sufficiently near $D_2 = 5890{\cdot}2$. It seems as if the other component, D_1, was entirely absent, although there remains an element of doubt as to the sufficiency of the dispersion employed. If 5891·9 is merely a blend of D_2 and D_1, their relative intensities should be about 3·5 to 1.

In the spectrum of Brooks' comet, Wright found both components, D_2 with wave-length 5889·4, and D_1 with wave-length 5895·5. He says. "Both of the D lines are present, forming a close double, D_2 being much the brighter." The relative intensities were estimated as 3 to 1.

Thus there would seem to be good astronomical evidence to the effect that sodium D lines are present in the spectra of certain comets and that they show very unequal intensity, D_1 being much weaker than D_2. If we take into account that D_1 may blend with the band 5897·5 of high-pressure carbon monoxide, as suggested by Fowler (*Monthly Notices, R.A.S.*, 70, 490, 1910), the contrast between D_1 and D_2 will be still greater. Laboratory conditions for the excitation of these high-pressure bands, however, would scarcely lead us to expect to find this spectrum in comets.

R W Wood has shown (*Phil. Mag* (6) **27**, 1018, 1914) that it is possible to excite D_2 by fluorescent methods with an intensity excessively greater than D_1.

One of us has recently observed the excitation of the D lines with relative intensities strongly suggestive of their appearance in comets, and under conditions of excitation which also are somewhat similar. The tube used was provided with a hot cathode about five millimetres in length, richly coated with oxides containing very minute traces of sodium as impurity. The anode was a nickel cylindrical Faraday cage entirely enclosed (except for an observation slot) in which the end opposite to and about one millimetre from the hot cathode consisted of iron gauze This grid-plate combination was maintained about 200 volts positive with respect to the filament

Using as high a filament temperature as could be safely maintained, and a residual gas pressure of carbon monoxide of about 10^{-4} cm or less, the radiation inside the cage exhibits chiefly the comet-tail bands with traces of the Ångstrom bands of carbon monoxide. Close to the hot filament, however, the D lines can be observed with an estimated intensity ratio $D_2 : D_1 = 5$ when the sodium spectrum is brighter than the comet tail spectrum. As the partial pressure of the sodium decreases, however, this ratio becomes much larger and of the order of 25 to 1. Indeed, when the sodium spectrum is fainter than the comet-tail spectrum, D_2 is the only line which can be observed visually. Conditions here obviously suggest those of a comet near perihelion, and it is hoped that further experimental work may shed more light on this interesting phenomenon.

Harvey B. Lemon.
N. T. Bobrovnikoff.

Ryerson Physical Laboratory,
March 17.

Applied Entomology.

I write to invite attention to the state of applied entomology, which seems to be capable of improvement in Great Britain and in other countries. We entomologists, whose profession it is to control or destroy the insects which carry diseases of men and domestic animals, or destroy our crops, can indeed claim that we have met with a certain measure of success, but some of us feel that the success is much less than might be expected, in view of the great amount of work which is done.

Entomology may be divided into two parts—the study of form and the study of function. It is the former (anatomy, both of adults and of early stages, systematics, etc.) which leads to correct identification, and enables us to preserve an orderly arrangement in our study of the half-million species of insects which are already known This is clearly of great importance, and on the whole one may say that it is well done. But the study of function—physiology in a wide sense of the word—is of even greater importance, because it is on a knowledge of all the vital activities of the insects that we base our control of them. I believe that the physiology of insects has been done in a superficial and disjointed manner, and that the reason is that the majority of workers feel compelled to produce results of some obvious practical importance. I believe that real progress will not be made in applied entomology until this mistake is realised, and until we devote time and labour to the study of the fundamentals of insect physiology.

For example, we know that the spread of plague is to some extent influenced by the effect of temperature and humidity on certain species of fleas; but we do not understand why high temperatures are fatal to some insects, or whether the effect of humidity on insects should be measured as relative humidity, or as saturation deficiency, or in what other way. Again, we know that the greater part of the response of an insect to its environment can be analysed into a number of tropisms, which are relatively simple. We scarcely study these problems of psychology, though it is possible that if we knew the stimuli which control the insects' behaviour we could predict or even alter the behaviour. As an example of this, it has been recently shown that if certain stimuli, such as darkness, are supplied, a species of mosquito will come freely to lay its eggs in water containing arsenic, which is fatal to the larva as soon as it leaves the egg. Then, again, most of the poisons which we use are in favour because they are known to be toxic to vertebrates. We lave the fair face of Nature with copper sulphate, and then powder her with Paris green, but we cannot find enough time to make a thorough study of the toxicology of insects.

I believe that progress in the control of noxious insects is at present hampered by our ignorance of the physiology of insects in general. By physiology I mean not only the study of the functions of isolated parts of an organism, but also the extremely difficult task of understanding the relations between the living insect and the whole of its environment, inorganic and organic.

P. A. Buxton.

London School of Hygiene and
Tropical Medicine,
Endsleigh Gardens, W.C.1.

The Anomalous Flocculation of Clay.

In recent years it has become common to speak of the flocculation of clay by calcium salts as being 'anomalous,' the particular anomaly being that whereas clay suspensions containing a little sodium chloride are stabilised by the addition of sodium hydroxide, in the case of calcium the flocculation is said to be facilitated rather than repressed by the addition of the alkali. Careful experiments, however, made with a highly purified clay suspension, have convinced us that this anomaly does not exist, and that calcium and sodium compounds behave alike except in respect to the concentration required for flocculation. The following figures show the concentration in equivalents of cation required for flocculation to be half completed in one hour, this being determined nephelometrically:

	Concentrations multiplied × 10⁴.	
	Sodium.	Calcium.
All chloride	70	5·6
All hydroxide	480	16 8
Two equivalents of chloride to one of hydroxide	560	19 3

These results are parallel and do not suggest anything more than that compounds of calcium are much more powerful flocculants than those of sodium

In carrying out this work, however, a much more interesting phenomenon has been noticed. If to a dilute clay suspension be added gradually increasing quantities of certain mixtures of chloride and hydroxide, and the effect on the flocculation or otherwise of the clay determined nephelometrically after one hour's standing, it is found that the flocculating effect first increases very rapidly with concentration, then rapidly falls off and then again increases without further falling off. The following table shows this for a few mixtures, and also exhibits the similarity in behaviour between sodium and calcium compounds. ' + ' means flocculated (one-half or more down in one hour), and ' – ' means no flocculation observed in an hour.

Conc × 10³ for Sodium Conc. × 10⁴ for Calcium.	5	20	40	60	80	100	120	140	160	180	200
$NaCl : NaOH$, 50 : 1 .	–	+	–	–	+	+	+	+	+	+	+
$NaCl : NaOH$, 175 : 1 .	–	+	+	+	–	–	–	–	+	+	+
$CaCl_2$, $Ca(OH)_2$, 2 : 1 .	–	–	–	–	+	+	+	–	–	–	+

In the case of sodium compounds, the phenomenon is exhibited with ratios for chloride to hydroxide varying between 25 and 175 to one: for calcium it is only shown in the neighbourhood of the ratio 2 to 1. Other mixtures do not show a minimum in the flocculation curves.

Interesting information is being obtained from the *p*H measurements of the mixtures at critical points, and it is hoped to publish a complete account of the observations shortly.

A. F. Joseph.
H. B. Oakley.

Wellcome Tropical Research Laboratories,
Khartoum, March 16.

X-ray Identification of the Higher Fatty Acids.

The fatty acids of higher carbon content than stearic acid are of general interest because of their occurrence in oils and fats now employed for edible purposes. Ultimate chemical analysis of higher fatty acids is inconclusive, because of the very slight percentage differences in the elementary composition of these closely related homologous substances, but X-ray examination gives data which are more decisive (Müller, *Chem. Soc. Trans.*, 1923, 123, 2043; Müller and Shearer, *ibid.* p. 3156).

In pursuance of our researches on acids from vegetable fats, including arachis or peanut oil (Morgan and Bowen, *J. Soc. Chem. Ind.*, 1924, 43, 346*T*; Morgan and Holmes, *loc. cit.*, 1925, 44, 108*T*, 219*T*, 491*T*), we have recently isolated from this oil an acid melting at 77° which has been shown by X-ray examination to be a C_{26} acid, almost certainly possessing an unbranched carbon chain. We are indebted to Dr. E. A. Owen of the National Physical Laboratory for the X-ray photograph.

This physical evidence confirms an observation published recently by Holde and Godbole (*Ber.*, 1926, 59, 36), who have shown that arachis oil contains a hexacosoic acid (m.p. 79°), this acid giving by alkalimetric titration a molecular weight of 394 (calculated 396).

As the chemical constitutions of higher fatty acids from arachis oil have recently been a matter of controversy (Ehrenstein and Stuewer, *J. prakt. Chem.*, 1923, 105, 199, and Cohen, *Proc. K. Akad., Wetensch., Amsterdam*, 1925, 28, 630), we are now examining the chemical and physical properties (including crystal structure) of certain higher fatty acids having branched carbon chains of predetermined configuration.

G. T. Morgan.
E. Holmes.

Chemical Research Laboratory,
Teddington, Middlesex.

The Campaign against Prickly-Pear in Australia.

WORK OF THE COMMONWEALTH PRICKLY-PEAR BOARD.

By ALAN P. DODD, Officer-in-Charge of the Investigations.

THE Commonwealth Prickly-Pear Board was instituted in 1920 to study the possibilities of the control of the prickly-pear pest in Australia by means of biological agencies. Previous investigations had established the fact that in its native home, America, prickly-pear is attacked by various insects and fungus diseases that appear to be confined to plants of the cactus family.

The Board at once commenced operations in North America, and has employed investigators in that country since; a more or less comprehensive survey has been carried out in the cactus regions of the United States, and brief excursions have been made into Mexico. South America, Argentine and Uruguay have been explored to a considerable extent. In the present year more extensive operations are planned in Mexico.

During the earlier portion of the work, attention was paid to the fungus and bacterial diseases of the cactus family, but owing to the need for special research in this subject and the inadequacy of the Board's finances, the work was allowed to lapse temporarily. However, in 1925, a research scholar in mycology was appointed and has commenced studies in the laboratories of several universities in the United States.

THE WORK IN AMERICA.

The cactus family is botanically a rather isolated group, and has evolved a considerable insect fauna that appears restricted to plants in the family. In the United States alone, the Board's entomologists have made known more than sixty species of insects that are primarily cactus feeders; in Mexico and South America other species occur; a number of these has proved new to science.

The work in America consists of the study of the insects in the field, and the breeding and forwarding of numbers of reared material, free from parasitic enemies, of all species that promise to be of use in the control of prickly-pear in Australia. Before shipments are sent, tests are carried out with each insect in order to ascertain the possibility of its being able to develop on other plants. These tests have given interesting results, and more than one insect has been eliminated because the tests showed that it was capable of sustaining its life cycle on certain economic plants. The tests are repeated in Australia against economic plants and native trees.

To date, about forty different species of cactus insects have been forwarded to Australia, in most cases many thousands of each.

THE WORK IN AUSTRALIA.

In Australia the Board has established a central laboratory at Sherwood, near Brisbane, and field stations at Westwood, near Rockhampton, Chinchilla, two hundred miles west from Brisbane, and Gravesend, on the Moree-Inverell railway in New South Wales. Sherwood acts as the quarantine station where the insects are received from America and bred through one generation to eliminate further the risk of the introduction of parasites that might exercise a serious check on the rapid multiplication of the desired insects; the bred material is then distributed to the field stations. The equipment at the field stations consists of insectaries and a great many breeding cages of various types. The function of these stations is to rear the insects in sufficient numbers to permit of liberations in the open.

Throughout the investigations one of the chief difficulties has been the acclimatisation of the introduced insects. It must be remembered that the seasons in North America are the reverse of those in Australia; thus, when an insect should be hibernating in the North American winter it must be actively feeding in an Australian summer. With most of the insects, repeated shipments over a period of two or three years have been necessary to secure their establishment in the rearing cages; indeed, certain species have quite failed to adapt themselves, either through the unsuitability of caged conditions, or to differences in climate.

Another phase of the work has been the study of the adaptability of the insects to Australian prickly-pears The two main species involved in Australia are the common pest pear, *Opuntia inermis*, and the spiny pest pear, *O. stricta*; lesser pests are the velvety tree pear, *O. tomentosa*, the smooth tree pear, *O. monacantha*, and the tiger pear, *O. aurantiaca*, while several other forms are found in scattered quantity. Very few cactus insects will attack all prickly-pears indiscriminately; most of them show a decided preference for certain forms, and in some cases will readily attack one pear and refuse to live on another.

INSECTS SUCCESSFULLY INTRODUCED INTO AUSTRALIA.

Of the insects successfully introduced into Australia, the most widely known are the cochineals, of which the most important is the wild cochineal, *D. tomentosus* Three strains of this insect have been brought into the country from Texas, Arizona, and Chico, California, the two first by the Board, the last by independent action. All three will live readily on the two chief pest pears, but the virulence of the attack varies. The Chico cochineal is most destructive to the common pest pear, *O. inermis*, the Texas form favours the spiny pest pear, *O. stricta*, while the Arizona strain seems to be equally suited by either plant. These cochineals are being widely spread throughout Queensland and New South Wales. They are doing splendid service in many places, especially in dense pear in timbered areas, breaking up the plant masses and destroying old plants; but probably the most useful feature of their work is the manner in which they attack the young seedlings. The Indian cochineal, *D. indicus*, was introduced in 1913 by the Queensland Prickly-Pear Travelling Commission, and will exist on the smooth tree pear, *O. monacantha*, only, completely destroying large clumps of this plant in the space of a few months.

Of the plant-sucking bugs, several species of the genus Chelinidea have been acclimatised; *C. tabulata* has been liberated in many places and has increased at a very rapid rate in the field; in fact, in some localities, millions must now be present from small numbers set free in the past two or three years. *C. vittiger* has also been released at various places.

Of the internal-feeding caterpillars, one species, *Melitara junctolineella*, has been readily acclimatised; about a million have been liberated, and it is now firmly established in several localities. These caterpillars are solitary in habit, and tunnel within the joints or pads of prickly-pear. A related insect is *Melitara prodenialis*, but the caterpillars are social in habit, a number feeding together within the pear pads; recently this species has been set free in the Westwood district, and promises to be especially useful as a pear destroyer.

One of the most recent of the Board's importations has been strikingly successful in so far as rapid increase is concerned. This insect is *Cactoblastis cactorum*, a social caterpillar allied to the Melitaras. Less than three thousand larvæ arrived from Argentine in May 1925, but the increase has been so great that in February and March 1926, nine months later, sufficient stocks had been raised to warrant the release of two and a half millions throughout the pear areas. These caterpillars are voracious feeders, and should the increase in the field be sustained at one-half the rate experienced in the cages, great destruction of pear should be brought about.

Many other insects are being bred and acclimatised, and the Board is continuing the introduction of new forms, believing that the control of prickly-pear by biological means can only be brought about by the combined attack of a variety of insects operating on the different parts of the plant.

Chemical and Physical Action at Surfaces.[1]

By Dr. Eric K. Rideal.

THE subject of colloid chemistry is intimately associated with the properties and peculiarities of interfaces, of which those formed by liquids and solids are the most important. The difficulties met with in an exact study of reactions taking place in colloidal systems are greatly enhanced by their dispersity, and in addition the application of thermodynamic methods to the treatment of the two-dimensional interfacial phases becomes a problem of great complexity when these phases are subdivided and not plane but curved. For these reasons the increasing attention which is being devoted to surface phenomena is a development to be welcomed. As the late Lord Rayleigh first indicated, the properties of oil films on water studied by Miss Pockels give us valuable information on molecular magnitudes, a view which has been emphasised and amply confirmed by the able experiments of numerous investigators, notably Devaux, Langmuir and Adam.

An examination of the process of spreading of oil films and their conditions of equilibrium presents several features which can be compared with phenomena occurring in three-dimensional systems. If a crystal of myristic acid be placed upon the surface of water a process of surface solution occurs, molecules are torn off the edge of the crystal in contact with the water by hydration of their polar or hydrophilic groups and float on the surface as a two-dimensional vapour. This process of surface solution continues until the vapour attains, as measured by the fall in surface tension of the water, the critical 'vapour pressure' value necessary for conversion into a two-dimensional liquid, the so-called expanded film of Adam. The liquid undergoes further two-dimensional compression by continued surface solution from the crystal, and if the temperature be sufficiently low, the expanded film is converted into a condensed film which may be liquid or solid. If the temperature be high, no formation of a condensed film occurs but the film remains in the expanded state. Compression does not proceed indefinitely, for the substance possesses but a finite surface solubility at a constant temperature and a saturation equilibrium is attained.

Both the rate of spread, which in the case of a rapidly spreading acid, such as oleic acid, rarely exceeds a linear speed of 25 cm. per second, as well as the progress of surface saturation and the transformation of the two-dimensional vapour into the expanded and condensed states, can readily be followed by observing the changes in surface tension at different points on the water when a cylinder of the acid is plunged below the surface. In the case of the spreading of solid acids, the rate of surface solution is so slow that no pressure gradient exists in the expanding film, but for acids which spread quickly molecules go into solution so rapidly that those already on the surface are actually pushed out by those entering, causing a local lowering of the surface tension.

For the long-chain fatty acids the molecular adhesion by the hydrocarbon tails is so great that these two-dimensional films, even at high temperatures, are analogous to vapours rather than gases. Substances which can exist in a state equivalent to two-dimensional gases on a water surface over the ordinary experimental temperature range must possess chains less than eleven carbon atoms long; these are appreciably soluble in water and their surface concentrations must be calculated by means of the Gibbs Thomson equation. It is found that if the force-area curves calculated in this manner for substances such as the short-chain fatty acids or alcohols on the surface of water, or at interfaces such as benzene-water or mercury-water, be plotted, they reproduce in all respects the pressure volume curves obtained by Amagat for gases at high pressures.

Not only can we examine the behaviour of matter in its various states in this two-dimensional system, but a knowledge of the variation of the equilibrium pressures with the temperature, and the application of the Clapeyron equation, also yields values for the latent heats of 'spreading' of these substances. We may note in addition that the potential difference existing at the boundary between a homogeneous aqueous phase and its vapour is profoundly modified by the presence of such films. From a knowledge of the surface concentration and the change in potential effected by the presence of the film, the change in electric moment caused by the introduction of one molecule of the fatty acid into the surface phase may be determined. If these be calculated for a number of organic substances, many interesting results are obtained: thus the electric moment of the fatty acids appears to reside entirely in the carboxyl group and is of a value equivalent to that produced by separating a proton and an electron to a distance of 0·06 Å.U. The moment of the alcoholic hydroxyl group is some twenty per cent. smaller. Very considerable changes in electric moment are caused by the introduction of the halogens or amino groups in place of hydrogen. Careful analysis of these changes may throw some light on the vexed question of polarity, which appears to be of some importance in organic chemistry.

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[1] Based upon two lectures delivered at the Royal Institution on February 2 and 9.

The experimental examination of the behaviour of gases and vapours at solid surfaces is a much more difficult problem, for whereas a liquid surface is a surface of equipotential, it is almost impossible to obtain solid surfaces uniform in surface energy. Calculations from the compressibility of cubic heteropolar crystals, such as rock salt, of the surface energies of various planes, have been made by Born and more ecently by Jones; the data, although admittedly only approximate in character, indicate enormous variations from face to face. Microscopic examination of the process of crystal growth, solution and etching, likewise support this conception of a variation in the forces of adhesion to crystal facets and edges. The change from a super-cooled liquid to a crystal may be regarded as resulting in a diminution in the potential nergy of the surface as well as of the material in the nterior.

These speculations lead us to the idea that the surface of a metal prepared, say, by the reduction of he oxide at low temperatures, is not a regular and uniform, if somewhat undulatory, checker board of equipotential points, but consists of portions of minute crystal edges, planes and corners in addition to numerous keletal chains of atoms awaiting the opportunities provided by thermal agitation for slipping into a more ompact crystal lattice. Both the interatomic distance, as well as the number and variety of atoms around one particular atom, affect the field of force which contributes to the adhesional potential energy of the surface. By a process of summation we may regard he surface as containing patches of varying activity n which substances are adsorbed but not with equal acility. Adsorption on a very active patch is associated with a large heat evolution and presumably also with a large decrease in the free energy of the system, nd the patch may become saturated with gas before the less active patches are more than sparsely covered. This conception of a variation in the 'availability' of surface, as an explanation for the experimental data indicating different saturation maxima for various gases nd vapours, cannot, however, be considered a general ne, for we find that many vapours, and possibly some ases, especially when near their critical points, may be adsorbed in layers more than one molecule thick. A ifference in the amounts of two vapours adsorbed at aturation may be interpreted as due to a difference in lm thickness.

Whilst the first or unimolecular layer is held on xtremely firmly, the decrease in free energy resulting n building up the subsequent layers is but small; their formation may be regarded as due to an increase in the molecular cohesion of a molecule resulting on adsorption rather than a direct attraction of the surface for a molecule some distance away. As a convenient analogy we may cite the example of a weak magnet holding a string of iron filings. A second filing may be attached to the free end of one already hanging from the magnet, but if the first one be removed a filing will not be drawn towards the magnet from the position originally occupied by the second.

In catalytic actions also which appear to be limited in action to the primary adsorbed film, we find that those portions which are unstable and readily adsorb gases are also catalytically active. Since the measure of the catalytic efficiency of a metal is the rate of reaction, it is clear that a relatively large area of the active surface is required. A variation in the closeness of packing, as well as an introduction of foreign elements, frequently alters the rate of reaction. There appear to be at least three different types of such active surfaces on carefully prepared nickel: on one all hydrogenation reactions, including saturation of ring compounds, may be performed; on a less active area, simple double bonds undergo hydrogenation but not ring compounds; and a third area facilitates only the reduction of nitro groups. In the case of carbon containing both iron and nitrogen, there exists a large area, inactive catalytically, for the oxidation of oxalic acid; but in addition there exist areas of active carbon, active carbon-nitrogen, active carbon-nitrogen-iron and active carbon-iron complexes; these all possess different specific surface activities and different temperature coefficients for the reaction velocities. Since the products of reaction must leave the surface before new reactants can approach, it is possible that there is an upper as well as a lower limit to the strength of field on the surface which is most desirable for an efficient catalyst.

There has been a great deal of speculation, founded upon little experimental work, as to the nature of the union between substrate and adsorbate and the mechanism by which some of these complexes are rendered active. That complex organic molecules are attached by particular groups, usually the polar or lyophilic group, to metals and oxides can be demonstrated in a number of cases; the union, however, is not so intimate as in a true chemical compound of the heteropolar type, for a ready distinction in ease of reduction is to be noted in the case of films of copper or nickel oxide and films of oxygen adsorbed on the metals. Again, a few interesting observations scattered in the literature would lead us to conclude that there exists an intimate connexion between the catalytic activity of a metal and those electrons in the metal capable of being ejected in thermionic emission. Hydrogen and oxygen, it is stated, commence to combine rapidly on a platinum wire which has been heated to such a temperature that the rate of thermionic emission becomes sensible; also a tungsten wire poisoned with a suitable impurity neither effects catalysis nor emits thermions. Finally, the investigations of Richardson on the possibility of different rates of thermionic emission from different parts of a metal surface are suggestive in connexion with the concept of areas of different activities.

Whilst our present knowledge of the mode of adsorption and type of binding is very incomplete, our information on the mechanism of activation is still scantier. It is in many cases difficult to obtain a measure of the true energy of activation, not only on account of the possible variation in stability of these adsorption compounds with the nature of the surface, but also because the velocity of the reaction, from the variation of which with the temperature these energies are obtained, may be determined by some other factor than the excitation of the reactant. Apart from these additional complexities, the fundamental problem of the mechanism of molecular activation in simple uni-, and possibly also in the case of bimolecular gas reactions, cannot be said to have received a successful solution.

Almost a decade has passed since Langmuir published his most stimulating paper on surface action, which did much to renew interest in this field. An enormous volume of experimental work has been accomplished during this time and the complexities of the subject have undoubtedly increased. In spite of this it is as full of interest as it was in the time of Faraday, and whilst many of the problems unsolved then await solution now, our knowledge of the processes occurring at surfaces still continues to increase.

Obituary.

Prof. W. J. Lewis, F.R.S.

THE sudden and unexpected death of Prof. W. J. Lewis deprives mineralogy of a well-known personality. He passed away peacefully in his sleep in the afternoon of April 16 at the house of his sister, Mrs. G. T. Pilcher, at Godalming, Surrey. William James Lewis, the second son of the Rev. John Lewis, was born at Llanwyddelan in Montgomeryshire on January 16, 1847, and was educated at Llanrwst Grammar School. Entering Jesus College, Oxford, as a scholar in 1865, he took first classes in Mathematical Moderations in 1867, in Mathematical Finals in 1868, and in Natural Science in 1869. He gained the Senior Mathematical Scholarship in 1871, and was elected a Fellow of Oriel College in 1872. Not being married, he held this fellowship until his death, and the funeral service was conducted in the chapel of Oriel College.

For a time (1870–71) Lewis was an assistant master at Cheltenham College, and in 1875 he became an assistant in the Mineralogical Department of the British Museum, which at that time was under the keepership of Prof. Story-Maskelyne in the old building at Bloomsbury. On account of his health he retired from this position in 1877, and was succeeded by Sir Lazarus Fletcher. At that time Lewis was ordered abroad and given only a year to live; but in spite of that he reached his eightieth year. He took the opportunity of joining two solar eclipse expeditions, making observations on the polarisation of the corona.

Lewis had studied crystallography under Prof. W. H. Miller at Cambridge in 1874, and in 1879 during Miller's illness he acted as his deputy. He took the Cambridge M.A. degree by incorporation in 1880, and since then had lived in rooms in Trinity College. In 1881 he was appointed professor of mineralogy in succession to Miller, who had held office since 1832. Between them they had thus held the chair for ninety-four years; and it seems to have been Lewis's ambition to beat the record created by Adam Sedgwick and McKenny Hughes, who had sat tightly in the Cambridge chair of geology for ninety-nine years. Fortunately, under the new regulations, this state of affairs cannot be repeated. The professorship of mineralogy, founded in 1808, had previously been held by E. D. Clarke, the botanist J. S. Henslow, and the celebrated William Whewell, Master of Trinity, and it has been closely connected with the development of the sciences of mineralogy and crystallography. The Millerian system of notation now in general use for the planes of crystals was conceived by Whewell and elaborated by Miller and the crystallographic constants still accepted fo many mineral-species were first published by Mille in his classical treatise on mineralogy. The Cambridg collection of minerals contains much material o historical value and interest, and it has been considerably added to by Lewis, notably by the acquisitio of the Carne and the Wiltshire collections.

Lewis encouraged many more students than in th old days, and mineralogy soon became a popula Tripos subject taken in conjunction with geology He was not a prolific author, the list of his origina papers being limited to twenty-one titles, many o them only short notes. The earliest, in 1875, on th crystallography of some organic compounds, wer published in the *Journal of the Chemical Society*, an others on the crystallography of various mineral (glaucodote, miargyrite, stephanite, albite, etc.) appeared in the *Philosophical Magazine* (and reprinte as the *Proceedings of the Crystallological Society*), th *Proceedings of the Cambridge Philosophical Society*, an the *Mineralogical Magazine*; some of them being als translated into German in the *Zeitschrift für Krystallographie und Mineralogie*. Lewis delighted in th intricacies and difficulties presented by twinne crystals, and in devising geometrical methods fo dealing with the rhombohedral system of crystal In later years the material described had been collecte by himself during his many trips to the Binnentha and other mineral localities in Switzerland. In 191 at the age of seventy-two years, when alone in th Lengenbach quarry, he had the misfortune to slip an break his leg. There he lay in the snow all night, an in the morning he found a piece of wood to bind as splint, thus enabling him to crawl out and fortunatel attract attention.

The most important work written by Lewis was hi "Treatise on Crystallography," published in 1899 i the series of Cambridge Manuals. In the preparatio of this book he spared no pains, and it remains the be text-book on geometrical crystallography. He als wrote in 1913 a history of the parish of North Wraxha in Wiltshire, which included a life of his friend Franc Harrison, the late rector.

Lewis acted as secretary of the Crystallologic Society from its foundation in 1876 until its amalgamation with the Mineralogical Society in 1883, and wa librarian of the Mineralogical Society since 1890 an president in 1909–12. He joined the Chemical Societ so long ago as 1869, the Royal Astronomical Society in 1873, and was elected a fellow of the Royal Society in 1909. To many Cambridge men he was well known as the director of the Cambridge University Scholastic Agency, which he founded as a private venture in 1884, long before the official Appointments Board; and in connexion with this he worked out an insurance scheme. L. J. S.

WE regret to announce the following deaths:

Sir Henry Christopher Mance, past president of the Institution of Electrical Engineers, on April 21, aged eighty-six years.

Admiral Sir John Franklin Parry, K.C.B., formerly Hydrographer of the Navy, and president in 1919 of the International Hydrographic Conference held in London, on April 21, aged sixty-two years.

News and Views.

IN our supplement this week Prof Eddington deals with a subject which has become of the greatest importance in cosmic physics, namely, the source from which the stars derive the enormous quantities of energy which they radiate continuously into space. The character of this source and the manner in which it is tapped are fundamental questions which lie at the very heart of the problem of stellar evolution, for so long as they remain undetermined the problem cannot be solved Indeed, the very idea that stars evolve at all is derived from the observation that they radiate more energy than they receive from extraneous sources. Internal energy, or its equivalent, must, therefore, be transformed into radiation, and the change in the star brought about by the transformation is its course of evolution. Historically, it is true, the problem has been attacked most strenuously by observing the actual course of the change, regardless of its origin, on the assumption that the statistical distribution of stars with respect to physical characteristics represents the history of a single star. This method of attack, however, so long as the fundamental problem of the source of stellar energy is ignored, can, by its very nature, lead to nothing more than a description of a process of which the mainspring is unknown, and it now appears doubtful whether even that degree of success has been attained, for our confidence in the identity of a star's course of development and the statistical curve has been rudely shaken. It is therefore a matter for satisfaction that we are at last in a position to deal with the problem radically, and Prof. Eddington's admirably impartial and penetrating discussion clears the ground for action.

THE one definite conclusion that emerges from the researches of Prof. Eddington and others is that if the history of a star follows the statistical curve, or any curve approximating to it, there must be a transformation of matter into radiation by annihilation of electrons and protons, unless current theories are hopelessly on the wrong track. The existence of such a transformation, revolutionary as it would have appeared a few years ago, has perhaps been accepted somewhat too readily, and Prof. Eddington very opportunely directs attention to some of the difficulties which it involves. It may, as he says, be possible to wriggle out of them, but it would be much more satisfactory if they released us of their own accord. It may be questioned, however, whether he has given sufficient weight to the physicist's objection to a critical stellar temperature of transformation, at any rate, the physicist is entitled to invite him to pursue his reply to its logical conclusion Speaking of the less drastic change of hydrogen into helium as an example, he says: "But helium exists, and it is not much use for the critic to urge that the stars are not hot enough for its formation unless he is prepared to show us a *hotter place*." The critic might retort that protons and electrons also exist, and presumably were created, and if a critical temperature suffices for their destruction, it might also permit their creation. If that process also takes place in the stars, the whole problem takes on a different aspect. But whether occurring in the stars or elsewhere, the creation of matter can scarcely be ignored in a cosmology which gives a prime importance to its annihilation.

ON May 6 Prof. Sigmund Freud reaches his seventieth birthday, and the occasion is being celebrated by the International Psycho-Analytical Association, branches of which are now established throughout Europe, in the United States, and in India A sum of money raised by the various constituent societies of the Association will be presented to Prof Freud to be used by him in aid of some work or individual worker in the field of psycho-analysis, and a large number of his co-workers and associates from various countries will be present in Vienna on May 6 to take part in the commemoration. Further, there will be special articles in the two European journals devoted to the study of psycho-analysis—*Die Zeitschrift* and *Imago* (Vienna)—and also in *The International Journal of Psycho-Analysis* (London), written by intimates and co-workers of Freud. Almost synchronising with his birthday is a new development in London in the shape of the first Psycho-Analytic Clinic, to be established this month by the Institute of Psycho-Analysis, which will become, it is hoped, a worthy memorial to Freud's work and inspiration In his own town of Vienna (Freud's actual birthplace was Freiburg, but since 1860 he has been associated with Vienna), of which he was made a freeman about two years ago, the municipal authority wished to make some public recognition of its great citizen, but Freud declined the honour Indeed, it is characteristic of Freud that he has always refused to come personally into the limelight, no matter how far and wide the echoes of his work reverberate.

To scientific workers it is unnecessary to stress the significance of Freud's work: it will suffice to say that whatever the future may reveal to modify his discoveries, through his work the whole outlook of psychology has been once and for all altered. Further, owing to this change, innumerable spheres of thought have been influenced and future investigators will utilise, knowingly or unknowingly, those discoveries in the realm of mind which are the outcome of Freud's genius aided by his life's unremitting labour. In accord with the continuous development of his thought, this year has seen the publication of a volume embodying his latest research on the important subject of anxiety: in "Angst, Hemmung, und Symptome," the problems of anxiety, inhibitions in relation to anxiety, and the creation of anxiety-neurosis are shown in fresh aspects. Freud himself has written that he does not know whether the developments from his work will be much or little, but that he has made many beginnings and has stimulated much thought and inquiry. The verdict of posterity will surely subscribe to his estimate save on the score of its modesty.

ON May 4 occurs the bicentenary of the birth of Major-General William Ray, a distinguished military engineer and one of the originators of the trigonometrical survey of Great Britain. Born in Lanarkshire and educated at Lanark Grammar School, at twenty years of age Ray entered the army and was immediately employed on road-making and map-making in Scotland. This was long before Telford's beneficent labours. Rising steadily in the service, Ray saw active service in Germany during 1759–63, and in 1765 became surveyor-general of the coasts and engineer for making military surveys of Great Britain. By 1783 he had become colonel of the Royal Engineers, and in the following year he measured the famous base on Hounslow Heath, 27,404 feet long. This work attracted much attention at the time, and the Royal Society awarded Ray the Copley Medal. From this base line the triangulation was carried down to the south coast, a verification base line of 28,535 feet being measured on Romsey Marsh, and on September 23, 1787, Ray met the French Commission which had carried the survey of France northward from Paris. With this work Cassini, Mechain and Legendre had been connected, the object being the determination of the relative positions of Greenwich and Paris observatories. Shortly after this Ray went to Lisbon for his health. He returned in April 1790, but died suddenly at his house in Argyll Street, London, on July 1, 1790, while engaged in correcting proofs of a paper for the Royal Society. Many of his maps are in the British Museum.

THE institution of experiments in the care of animals, which will be followed with much interest, are recorded in the "Reports of the Council and Auditors of the Zoological Society of London for 1925," presented at the annual meeting of the Society on Thursday, April 29. Observations on a limited scale have indicated that animals, especially natives of tropical climes, thrive better in the presence of radiant light and heat and in an atmosphere of cold fresh air associated with warmed shelves. Accordingly, the cave-shelters in the new rock-work enclosure behind the Mappin Terraces, which accommodate a troop of 80 Hamadryas baboons, have been fitted with wooden shelves warmed from below by electric radiators and lighted from above by quartz incandescent lamps, which are permeable to ultra-violet rays. Some of the outside rocky ledges have also been warmed electrically and lighted by quartz lamps which can be turned on to diffuse 'artificial sun-light' when the weather is dull. Similar fittings, which, for upwards of a year, have been tested with delicate monkeys, such as a young orang-utan and marmosets, in the full-size model of part of a proposed new Ape and Monkey House, have given most promising results. In furtherance of the same policy, an attempt has been made to utilise the full value of natural light by replacing the ordinary glass of the whole roof of the lion house by 'vitaglass,' which is permeable to the ultra-violet rays of the sun. The success of these experiments would cause a revolution in the lighting and heating of the shelters and cages in zoological gardens, and a much-needed amelioration in the living conditions of many tropical animals, which in most gardens and under the best conditions are subject to a heavy disease and death rate.

DR. H. J. ROSE delivered a lecture on "Prehistoric Greece and Mother-right" to the Folk-Lore Society on April 21. The lecture was an elaboration and extension in the light of further research of an article contributed by Dr. Rose to *Folk-Lore* in 1911, and a confirmation of his earlier conclusion that no evidence of mother-right existed in early Greece. Such possible sources of evidence as the well-known inscription at Kos, the Code of Gortyn, the two plays the "Suppliants" and the "Eumenides" of Æschylus, and the genealogies from the old historians and from Pausanias which have been interpreted by many authorities as indicating a matrilinear system, were discussed in detail. The entries of the Kos inscription, which state specifically that the right to participate in the sacred rites was derived from the mother, are regarded by Dr. Rose as exceptional cases, probably due to the peculiar position occupied by heiresses under Greek law, and the stories of the Danaids and of Orestes and Clytemnestra as told by Æschylus were rejected as warranting an assumption of mother-right after a close consideration of the plays themselves. The genealogies were compared with the earlier traditions on which they were based, and were shown to be frequently at variance with them and not therefore wholly trustworthy as evidence. The paper is to be published in an early issue of *Folk-Lore*.

A LOST city of the Mayas in Yucatan is described in a further account of Dr. Gann's journey of exploration in Central America, which appeared in the *Morning Post* of April 19 and two succeeding days. A reference to a migration of the people of Chichen Itza eastward to "the settlement of the priest of Coba," in a recently translated portion of the Book of Chilam Balaam, appeared to confirm information given to Stevens in 1842 and suggested a search in the neighbourhood of Chemax, an Indian settlement in the Chichen Itza region. The result was the discovery of a city of considerable size and at present unique in presenting three distinct types of Masa civilisation. The oldest style of Maya architecture is here represented by an enormous temple, stelae, and ranges of arched rooms. It is followed by the Tuluum type, represented by flat-roof, stucco-covered buildings Last comes the Labaantum type—a great stairway similar to that discovered by Dr. Gánn and Mr. Mitchell-Hodges during their expedition last year. In no other town have these three styles previously been found together. The city probably was founded about A D. 926. Although it was occupied throughout the Toltec domination, it nowhere shows the influence of that people. A remarkable structure discovered on the road to Coba was a raised causeway, 32 ft. wide, and said by Dr Gann's native guide to be fifty miles long It was built of limestone rubble, and had been cemented on the surface Dr. Gann is of the opinion that it must have been a sacred way for ceremonial use from Chichen Itza to Coba Nothing like it is known elsewhere in Maya culture.

AT the meeting of the Circle of Scientific, Technical and Trade Journalists on April 19, Mr. J. G Pearce opened a discussion on "A Clearing House for Information: its Value to Science and Industry, and its relation to the Press" Mr Pearce gave an account of the work of the Association of Special Libraries and Information Bureaux, with which he is prominently associated. He remarked on two main characteristics of these times. the vast increase in the amount of "fact-information" available, as a consequence of scientific and industrial research, and the greater appetite for such information on the part of the general public The press fulfils a most useful function in making such information known, but much of it is stored away and unknown to those in need of it. On the Continent efforts have been made to initiate vast schemes of filing and tabulating all available information. But such methods, though admirable as repositories for the future historian, are too complicated for everyday use. He therefore advocated the establishment of information bureaux and the setting up of a "clearing house" which would prepare a directory of sources of information in Great Britain. In the course of the discussion a letter from Mr. Bradford, the Director of the Science Library, South Kensington, was read. He referred to the unique resources of this Library and the tabulation of foreign bibliographies which is being undertaken, and suggested that a simple extension of its organisation would suffice to convert the Science Library into a general bureau of information There was an interesting discussion, and general agreement was expressed with the principle of linking up existing libraries and rendering their contents better known To the technical journalist, any steps likely to make such information more readily accessible will be of special value.

ANY misgivings as to the nature and effect of the restoration work on the Sphinx carried out by Mr. Baraize under the Egyptian Department of Antiquities during the past winter should be allayed by the detailed account given by the Cairo correspondent of the *Times* in the issue of April 23. There is no doubt that the work was urgently necessary. It would appear that the head was in an exceedingly bad condition Huge cracks and cavities had appeared in the head-dress, part of which, together with the back of the neck, had been completely eroded. In fact, there was danger that the head might topple forward. There was also a deep gash on the left side of the head. All these cracks have been filled in, masonry has been built on to the back of the neck to preserve the centre of gravity, and two pieces of the head-dress found on the ground have been replaced A hole in the head, which might have been made anciently by treasure hunters, and is large enough to take a man standing erect, has now been fitted with an iron cover. The clearing away of the sand, which had silted up to the shoulders, has revealed the serious extent of the erosion caused by wind-blown sand, after the limestone casing repaired by Tothmes IV and the Ptolemies had been removed for building purposes. In contrast, the stonework now uncovered has all the appearance of being new. An interesting result which has emerged owing to the work of restoration, is the confirmation of the story that the monument was repaired by Tothmes IV. The striking lack of proportion between the head, the body and the paws has also been revealed.

PROF R WHIDDINGTON in his Friday evening discourse at the Royal Institution on "The Luminous Discharge through Rare Gases," delivered on April 23, stated that it has been known for a long time that when a gas in a glass tube is reduced in pressure, a stage arrives when an electric current can be passed with comparative ease along the length of the tube. One of the most striking effects of the current is the luminosity it produces in the gas. The tube becomes a source of light, just as the filament of an electric lamp does when the current passes through it. There is this fundamental difference, however, between the two cases. In the electric lamp filament the current is regarded as being carried wholly by electrons which, in threading their way through the closely packed and practically immobile atoms of the metal filament, produce the heat which raise it to incandescence. In the case of the gas in the discharge tube, the atoms are free to move as well as the electrons, which involves (*a*) that the atoms, when bombarded by the current-carrying electrons, frequently lose electrons themselves, becoming ions, and therefore assist in carrying the current by moving in a direction opposite to that of the electrons; (*b*) the gas in the tube emits light of a definite set of colours characteristic of the gas. In the case of the rare gases (argon and neon have been examined so far) new effects have been observed and interpreted. If a tube containing neon is viewed in a rotating mirror, it will be observed to be crossed by two sets of dark bands. The very broad sets are due to the alternating nature of the electric supply, but the very narrow bands are due to the mechanism of conduction of the current by ions and electrons.

As part of his course of lectures on "Organs of Multiple Function" delivered at the Royal Institution, Prof. J. Barcroft on April 21 dealt with the spleen. Of all the bulky organs of the body the function of this alone has not been fully elucidated. The ancients are alleged to have improved the athletic potentiality of their runners by cutting this organ completely out, their argument being that the spleen was the seat of that unpleasant sensation, the stitch; but this does not appear to be justified by the records. Later it became associated with testiness of character. It is nowadays sometimes excised without fatal or even very distressing effects. Thomas Gray expressed his view of the spleen as being for the purpose of regulating the quantity and quality of the blood. Within this phrase can be grouped a multitude of functions. We may address ourselves to two: one affecting the quality and the other the quantity. The spleen is a muscular bag which when it distends becomes engorged with blood; yet this blood is not ordinary blood. For the spleen is also a sieve, at least functionally, and it appears to sift out and fill itself with red corpuscles of a certain kind. The variety selected is that which is reputed to be the oldest, and is most easily broken down by exposure to reagents, such as dilute salt solution. These corpuscles appear in many cases to die in the spleen, so that the spleen has become the reputed cemetery of red corpuscles. As regards quantity, in many animals the extent to which the spleen can absorb blood is such that a considerable proportion of all the blood in the body can be held by the spleen. When the body needs blood the spleen empties itself into the general circulation. This is the case when exercise is taken, when the animal is slowly poisoned with coal-gas or if the animal loses blood by hæmorrhage. On the other hand, if unnecessary quantities of blood are in circulation, the spleen dilates and blood is withdrawn. Such would appear to happen when undue strain is put on the heart

EDUCATION and research in forestry continue to make good progress at Oxford. The Imperial Forestry Institute started work in October 1924; and its first annual report has just been issued by the Director, Prof. R. S. Troup. Advanced courses of instruction in the ordinary forestry subjects were given by the Director and eleven lecturers, of whom two, a silviculturist and an entomologist, are attached to the Institute by the Forestry Commission. The students, 22 in all, included 11 post-graduate probationers for the British and Colonial Forest Services, 8 forest officers on leave from the Colonies and India, and 3 students doing special work on the structure and properties of wood A special feature in the training was the practical instruction given on the Continent for the purpose of studying the latest developments in silvicultural systems, forest management and exploitation. Some of the Colonial students studied systematic botany at Kew. The staff of the Institute was fully occupied during the year in giving courses of instruction, in procuring equipment and material for study and in other preliminary duties, and had no opportunity for research work; but this will be prosecuted when the Institute is in full working order. At the School of Forestry, Oxford, 32 students attended during the academic year 1924–25 the usual courses of instruction for the Degree and Diploma in Forestry.

IN his inaugural address on April 20, Prof. Lelean, the newly appointed professor of public health in the University of Edinburgh, said that it is a hard doctrine for individuals that the grown-ups of every generation have already had their day. But it is a worse doctrine for the race that 95 per cent. of the available funds should be spent in tinkering with the present C3-ridden generation while only 5 per cent. is expended upon the evolution of a new generation so fit that it can defy disease. Expectant mothers and growing children should be placed under conditions so physiologically-favourable that the next generation will be overwhelmingly A1. He urged the elimination of non-essentials in education, and stated that some at least of the younger children are being pressed beyond their mental powers, and that a large proportion of the older children, especially in the better-class day schools, are being seriously overworked—the result of too high examination standards and overloaded curricula. He advocated a lowering of the present examination standards and education curricula, a reduction in the amount of home work, and a seat for some physiological expert—preferably the school medical officer—on every education committee in Great Britain.

THE first conversazione this year of the Royal Society will be held on Wednesday, May 12, at 8.30 o'clock.

SIR NAPIER SHAW, honorary member of the International Meteorological Committee, has been elected an honorary member of the Norwegian Academy of Sciences, Oslo, in the Class for Mathematics and Natural Science.

THE tenth lecture of the series, "Physics in Industry," being given under the auspices of the Institute of Physics, will be delivered by Mr. H. E. Wimperis, Director of Scientific Research, Air Ministry, who will take as his subject, "The Relationship of Physics to Aeronautical Research." The lecture, which will be open to the public, will be given in the Physics Theatre, Royal College of Science, Imperial Institute Road, South Kensington, S.W.7, on Tuesday, May 11, at 5.30 P.M.

IN our issue of December 26, 1925, p. 935, Prof. R. A. Sampson, President of the International Time Commission, announced that a new series of wireless time signals issued by the International Time Bureau at Paris would be in operation from the stations Eiffel Tower (FL) and Lafayette, Bordeaux (LY), from January 1 until April 30. It has now been decided to continue them as at present for a further period. Notice will be given when a change is made.

THE Society for Experimental Biology held its spring meeting at the Marine Biological Laboratory, Plymouth, on April 17 and 18. The programme included a symposium on the regulation of the environment and its effect on plants and animals, by Messrs. J. T. Saunders, W. H. Pearsall, and B W. Keen, dealing respectively with marine and fresh-water plankton and soil organisms and conditions. Dr. F. S. Russell contributed a paper on the factors affecting the vertical distribution of plankton, and Dr. E. M. Delf and Mr. A. D. Cotton discussed certain aspects of the ecology of marine algæ. There were numerous exhibits, as well as further papers on ciliary control, muscle contractility, and the œstrus cycle. About eighty attended the meeting, which included excursions to Cawsand and concluded with a dinner.

BY an Order of the Committee of Privy Council, Lieut.-General Sir William B. Leishman, director-general, Army Medical Services, has been appointed a member of the Medical Research Council. The vacancy thus filled was consequent upon the recent approval of amendments to the Royal Charter of the Medical Research Council, which provide *inter alia* for an increase in the number of members from ten to eleven. Under the amended charter, two of the eight scientific members will retire in each year, and one of the three other members in each second year, the scientific members being not eligible for re-appointment before the end of one year after retirement

THE Minister of Health will open the new laboratories of the Pharmaceutical Society of Great Britain on Wednesday, May 5. These laboratories were established by the Society for the testing of those therapeutic substances which will be scheduled under the Therapeutic Substances Act 1925. They comprise among other substances such important medicinal agents as digitalis, strophanthus, ergot and pituitary extract, the purity and potency of which cannot adequately be determined by chemical means The laboratories are being carried on under the direction of the council of the Society with the assistance of an advisory committee, including among others Sir Humphry Rolleston, Sir Nestor Tirard, Dr. H. H. Dale, and Prof. W. E. Dixon of Cambridge. Dr. J. H Burn has been appointed director of the new laboratories, and it is intended that pharmacological research should be carried on in addition to the routine testing of therapeutic substances.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned.—An assistant lecturer in mechanical engineering at the Brighton Technical College—The Secretary, Education Offices, Old Steine, Brighton (May 26). A professor of physiology at the Royal College of Surgeons in Ireland—The Registrar of the College, Dublin (May 28). Part-time lecturers in public health, and forensic medicine and toxicology, in the University of Bristol—The Registrar (May 30). A principal of the County Technical School, Stafford (candidates to be engineers) — The Director of Education, County Education Offices, Stafford (May 31). A head of the engineering department of the County Technical College, Wednesbury, and county lecturer in engineering for South Staffordshire—The Director of Education, County Education Offices, Stafford (May 31). A chemist at the Aeronautical Inspection Department Test House, Kidbrooke, S E.—The Secretary, Air Ministry, Adastral House, Kingsway, W C 2 A temporary metallurgist under the Directorate of Metallurgical Research, Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S E.18.

Our Astronomical Column.

FIREBALL ON APRIL 9.—Mr. W. F Denning writes that a brilliant fireball was observed passing over the east of England on April 9 at 11.30 P.M. G M.T It was seen from various places in the eastern counties and so far north as Westgate, Durham, but the late hour at which the object appeared must have greatly limited the number of its observers. The meteor was of remarkable brilliancy, for it vividly illuminated the country-side, and its sudden apparition on a moonless night was of somewhat startling character. It moved slowly and the nucleus threw off a number of red sparks, but the duration of flight did not exceed five seconds according to the careful estimate of a spectator near Harwich

The radiant point appears to have been in Virgo, at 208° − 11°, and the height of the object declined from 71 to 42 miles during a path of about 71 miles with a velocity of 15 miles per second. The meteor passed from over the south part of Essex to north of Norfolk, its motion being directed from S by E. The radiant in Virgo is that of a well-known April shower which has been frequently recognised in past years, and particularly on about April 8.

RELATIVITY SHIFT OF SOLAR SPECTRUM LINES.—In the *Proceedings of the National Academy of Sciences*, vol. 12, No 2, Dr. C. E St. John, of the Mount Wilson Observatory, makes a further contribution to the problem of the relativity shift of the solar spectrum lines. In a study of 331 iron lines, he finds a general displacement to the red, as required by the theory of relativity, but the amount of the displacement agrees with the theoretical value only for the lines of moderate intensity. Strong lines are displaced about 50 per cent. too much, and weak lines about 30 per cent. too little The explanation offered is based on the assumption that the deviations from theory are connected, not directly with intensities but with the levels in the sun's atmosphere at which the lines originate, these levels being indicated by the intensities. The observations can then be accounted for in terms of three disturbing influences: (1) The relativity displacement, affecting all lines in all parts of the sun; (2) radial movements of the atmospheric gases, downwards at very high and upwards at very low levels, these produce a maximum effect at the centre of the disc and no effect at all at the limb; (3) differential scattering, tending to widen the lines at the red edges, and producing a much greater effect at the limb than at the centre of the disc because of the greater depth of atmosphere traversed. The last-named influence is held to account for the so-called 'limb-effect,' which has long been known

Research Items.

Prehistoric Discoveries at Prestatyn.—Some interesting evidence bearing upon the possibility of the survival of a palæolithic people in Wales into the Neolithic and Bronze and even into the Iron Ages has been obtained from excavations carried out during the last two and a half years in the neighbourhood of Prestatyn. According to a recent lecture by Mr. F. Gilbert Smith, delivered under the auspices of the Dyserth and District Field Club, the 'Byrn Newydd' people began to settle in that area after the last phase of the Ice Age. The original site of occupation is directly on the boulder clay, now from one and a half to five feet below the present surface level. The implement-bearing zone begins at a depth of about one foot. Of three mounds or islands in a basin of boulder clay, one, the smallest, which had been used as a workshop, had been sealed, after its abandonment, by a deposit of two feet of tufa, and had thus remained untouched by the influence of later cultures. The implements found here included a large number of typical Tardenoisian form with battered backs and cores. They are of chert of exceptional quality, and are worked with great skill. Conclusive evidence for the contact between this culture of epipalæolithic type and that of a later phase is furnished by the discovery of a flint spear-head and a polished stone celt in a 'fire-place' on one of the larger islands in association with artefacts, in the main of the type found in the workshop.

Magic in Madeira.—Mr. James Hornell has recently made a study of superstitions connected with the evil eye in Madeira, and has published in the *Journal of the Royal Anthropological Institute*, Vol. 55, Pt. 2, an account of those in which the horns of various animals or substitutes therefor are used to avert evil. There is little overt evidence of this use, and indeed it was denied except in the case of protecting pigs against "bad air." Further inquiry showed, however, that the horns were used in several different ways. In fishing-boats they are employed as amulets against envy or the evil eye, but great secrecy about them is preserved, and they are kept in lockers under the decking. They are only mounted on the prow as a general observance when returning home on the popular festival of May 1—a pagan, not a religious festival. Horns are also used, but rarely, to protect crops. Though horns are not placed outside a house or over the door, the owner's possessions are protected by keeping a pair inside. The horns of a black goat or sheep are held to be the most efficacious. The familiar sign of the horns made with the hand is used and the amulet itself and its name are employed as a deadly insult to a married man, imputing infidelity on the part of his wife. It is probable that the use of an amulet in the form of horns is to be traced to a devil cult, the special efficacy of the goats' horns being significant in view of the belief that the devil when presiding over the witches' assemblies normally took the form of a horned goat. Further, it is to be noted that the amulet should be black.

Fœtal Ossification.—The economic conditions which existed in Switzerland during the later years of the War gave Messrs. Kupfer and Schinz opportunities of collecting in slaughterhouses a series of specimens which illustrate every stage in the development and growth of fœtal calves ("Beiträge zur Kenntnis der Skelettbildung bei domestizierten Saugetieren auf Grund rontgenologischer Untersuchungen." Von M. Kupfer und H. R. Schinz. Denkschriften der Schweizerischen Naturforschenden Gesellschaft. Band 69.) Every stage has been X-rayed, and complete records made of the sequence in which the centres of ossification make their appearance in the bones of the limbs. The results of this investigation are graphically summed up in 68 text figures, while 26 photographic plates set out very clearly some of the data on which conclusions are based. These conclusions are that in spite of the dissimilar purposes served by the limbs of the ox and of man, yet the number of centres of ossification which appear in the limbs of each is the same, and the order in which these centres appear is also the same. In the limbs of the calf all centres have appeared by the time of birth, whereas in man their appearance is extended until the age of puberty is reached. The authors also discuss the laws of ossification as revealed by their studies; their conclusions are in agreement with those which have been formulated by anatomists for the centres of the human body. Besides observing centres of ossification, the authors of this monograph have reinvestigated the cartilaginous skeleton which is laid down in the limbs of the fœtal calf. The shaft of the fibula, after being laid down in cartilage, disappears, all save its extremities, which become ossified and persist. The digits corresponding to man's great toe and thumb have no embryological representation at any stage, but those which correspond to man's second and fifth digits are formed in cartilage and afterwards undergo atrophy. Thus it will be seen that this monograph contains much new and exact information and should be accessible to all who are investigating skeletal problems. Fortunately for the progress of knowledge, the authors were able to publish their results through subventions placed at their disposal by societies in Zurich.

Expectation of Life.—It is well known that the expectation of life at birth, *i.e.* the average duration of life, has considerably increased during the last thirty years; for males in London from 41·2 years to 53·8 years. This has been brought about chiefly by a falling death-rate in infancy and the early years of life. It is not so well appreciated that the expectation of life of the elderly has not correspondingly increased during this period. This fact is discussed by Prof. Raymond Pearl (*Natural History*, vol. 26, 1926, p. 26), who finds that the evidence available does not indicate that any increase is occurring now, or has occurred, in the recorded expectation of life of persons who live to the age of 75 years or more. Still less is there any evidence that the biological upper limit of the human life span has been raised.

Marine Biological Research.—The recent issue of the *Journal of the Marine Biological Association* illustrates the general interest at the present day in the basal conditions of the environment in relation to the living organism, conditions which are at the root of economic research. The marine laboratories are naturally concerned with water-living organisms, and there are records of work by Atkins on the silica content of water, by Orr and Harvey on the nitrite and nitrate contents respectively, and by Poole and Atkins on the penetration of light into sea water. For the latter a new apparatus, consisting of photometers and photo-electric cells, is described. The other authors also bring forward improvements in technique but much further research on this side is necessary especially for the quick estimation of combined nitrogen. The greater concentration of the latter in deeper water is what is to be expected, as the phytoplankton necessarily uses up the combined nitrogen the organic proteins thus formed being afterwards broken down to simple compounds giving determinate cycles analogous to phosphates, etc. Of other matter, Russell's pelagic young of fishes is the second half of a research dealing with the vertical distribution of the macroplankton off Plymouth; it has a tentative list of distribution types, but we prefer to regard this work as preliminary to a deeper and more continued investigation. Miss Lebour completes the life histories of the Euphausidæ of the English Channel, the elucidation of which was of importance, as they are fed on largely by herring, hake, and other fishes. Dr. Amemiya records salinity experiments on the development stages of oysters. Lastly, the work of Fox on lunar periodicity in reproduction is confirmed by Orton in oysters, the normal forms in 1925 showing "three maximal percentages in spawn in the weeks after the July, August and September full moons."

FREQUENCY CURVES IN HERRING INVESTIGATIONS.—In his report of "Norwegian Fishery and Marine Investigations," Vol. iii, No. 4, Dr. Einar Lea has given an important reply to Miss Catherine W. M. Sherriff's report on her mathematical analysis of random samples of herrings ("Fisheries, Scotland," Sci Invest., 1922). Miss Sherriff was able to show that some of the empirical curves of frequency for the length of fish and for the number of rings counted on the scales, could be very well represented by one or other of the theoretical curves of variation, while others which were bimodal could be represented by the addition of two such curves. Prof. d'Arcy W. Thompson wrote an introductory note to Miss Sherriff's report, and it is the import of this note, rather than the results obtained by Miss Sherriff, which has attracted Einar Lea's attention. Lea infers that Prof d'Arcy Thompson considers the conformity between the empirical curves of frequency and the theoretical curves of variation to be a criterion in deciding whether a sample of herrings contains a single year group or several. Mathematicians will follow with interest the argument by which Lea comes to the conclusion that empirical curves of frequency, of which the similarity to theoretical curves of probability or variation cannot be doubted, may arise from and represent processes which have nothing to do with variation and variability in the sense given to these terms by Prof. d'Arcy Thompson. The curve of frequency for the length of the herrings in a random sample may easily show sufficient degree of similarity to a theoretical curve of variation even though the individuals in the sample belong to several age groups, and the curve of frequency for the number of rings on the scales may also have a form which is so like a theoretical curve of variation that it might be mistaken for one, without this fact arguing against the assumption that the rings are annual rings; and that consequently the curve of frequency represents the distribution of age in the shoal from which the sample comes.

INFLUENCE OF TEMPERATURE ON THE LOCUST.—In the *Bulletin of Entomological Research* for March 1926, Prof. V. P. Pospelov describes some experiments showing that temperature during breeding exercises great influence on the development of the locust *Locusta migratoria* L.) There is a certain limit of favourable temperature below which development of the genital products in the imagines ceases and the insects easily succumb to bacterial diseases. Young insects kept at a temperature of 35°-38° C. and with humidity near the saturation point developed rapidly, became adults, and commenced oviposition. In a second experiment, insects during their first two instars were kept under these same conditions. When in the third instar, they were transferred to a temperature of 30° C. by day and 20° C. by night with humidity at about 70 per cent.; they became sluggish, ate very little, and those which ultimately became adult failed to mature sexually and died without laying eggs. Observations were also carried out with reference to the occurrence of *Coccobacillus acridiorum* in the blood, and the results obtained confirmed the opinion of Mereshkovsky that this organism is a normal symbiont of locusts, but becomes a parasite under unfavourable conditions of temperature and humidity.

PLANT COLONISATION OF THE SEA-SHORE.—Prof. F. W. Oliver has an interesting account of the spread of *Spartina Townsendii* in the Seine estuary, between Havre and Tancarville, in the *Gardener's Chronicle* for March 20. Unlike the process of colonisation in Poole Harbour, where Spartina follows upon Zostera, on the Seine Spartina is settling upon virgin ground. As Spartina appears to have been unknown in the Havre district ten years ago, the advance made by the plant since is a very striking example of its powers of rapid colonisation. A further striking point is that in various local patches Prof Oliver seems to find clear evidence that Spartina, the coloniser, has in its turn been ousted and replaced by *Glyceria maritima*. The species is unusually luxuriant in its growth and is apparently particularly favoured by some of the local habitat conditions. In *Modern Science* for April 1926 Prof. Mangham of Southampton discusses another sea-shore coloniser, *Sueda fruticosa*, an almost evergreen, tough, woody shrub, which he suggests might be tried out as a practical method of delaying or arresting the inward movement of mobile shingle banks in various seacoast areas.

NATURAL WOUND HEALING IN TREES.—Mr. T. Swarbrick has a paper on this subject in the *Journal of Pomology and Horticultural Science* (vol. 5, No. 2, March 1926). The outstanding result is that in all the species of trees examined (in a Yorkshire area), study of the natural processes involved in healing showed that, if the wounds were made during the months May to August inclusive, they were soon blocked against the entry of disease organisms; on the other hand, wounds made in September and October may block partially, and wounds made during November to April, scarcely at all, as the result of natural changes at the cut surface. Anatomical and micro-chemical details are supplied as to the nature of this process of blocking, which is mainly due to a gradual plugging of vessels and tracheids by 'wound gum' secreted from the starch containing cells in the neighbourhood of the cut. Such blocking is much more rapid than any subsequent healing by the inward growth of callus tissue from the periphery of the cut stump These data would seem to be of interest in connexion with the practical operations of pruning, etc., by which cut surface of woody branches are exposed to the entry of disease organisms at various seasons.

MYCORHIZA.—Dr. M. C. Rayner has commenced in the *New Phytologist* (vol. 25, No. 1, 1926) a monographic account of this subject which will be of very great value to botanical workers. The literature of the subject, whilst very extensive, is so very scattered, the problem of association of fungus and flowering plant being capable of attack from so many points of view, that as a result the subject certainly lacks adequate presentation in modern text-books, and there is no doubt that an impetus to the study of a widespread phenomenon should be the result of this publication. Dr. Rayner's first instalment of this study, with its account of Kamienski's pioneer work upon Monotropa, its full analysis of the classic researches of Frank, with its quotation from the original papers and reproductions of some of the figures published by these earlier authors, certainly provides most botanists with a sounder basis upon which to commence its examination than could be readily provided otherwise save by long searching through the literature. It was also a happy idea to quote again de Bary's original definition of symbiosis, in view of the long controversy as to the relative value to flowering plant and fungus of their close relationship. De Bary, as Dr. Rayner points out, clearly intended symbiosis to include all cases of mutual relationship in life of two organisms, including parasitism.

Records of Plants.—The *Kew Bulletin* No. 2 for 1926 contains some very good photographs of the remarkable tree *Clistoyucca arborescens* Trelease, which grows in 'forests' in the Mohave desert, Los Angeles, California; it is separated from the genus Yucca mainly on account of the very thick perianth segments and the absence of a style C. E. Hubbard gives the full taxonomy of a useful fodder grass, *Paspalum Larranagai* Arech., "Vasey grass," a native of South America, it has now been introduced into North America and South Africa. L. A. M. Riley supplies notes on the flora of Rapa Island, visited by the *St. George* during the Pacific Expedition, 1924–5. Rapa is 250 miles to the S.E. of the Australs, and of the seventeen species collected there, four are apparently new to science. Under the heading "Spolia Mentawiensia," Mr. C. Boden Kloss states that it is proposed to give an account of the results, mainly zoological and to be published in various journals, which were obtained by a collecting expedition in 1924 in the Mentawi group of islands to the west of Sumatra. A beginning is made by an account of the flora by Mr. H. W. Ridley. Mr. W. B. Turrill has some notes on the flora of the nearer East in the same number of the journal.

Magnetic Observations.—The March issue of the *Journal of the Washington Academy of Sciences*, 16, p. 109, 1926, contains an interesting lecture on "The Magnetic and Electric Survey of the Earth, its Physical and Cosmical Bearings and Development," by J. A. Fleming, of the Department of Terrestrial Magnetism, Washington. The lecture sketches very briefly the historical development of terrestrial magnetic and electric observation up to its present extensive and detailed though still incomplete stage. There are now about fifty active magnetic observatories, of which less than 20 per cent. carry on electric work; 40 per cent are in Europe, and less than 20 per cent. in the southern hemisphere. The polar regions are naturally very scantily supplied, a most regrettable fact in view of the interest and importance of the auroral and magnetic phenomena which there attain special intensity. As regards the general magnetic field, even in well-surveyed regions magnetic observations must be continually repeated at regular intervals in order to keep the magnetic charts up-to-date, on account of the rapid and incalculable secular variations in the earth's field: these changes are complicated even over the deep sea.

Colorimetry.—A considerable portion of part 2 of volume 27 of the *Transactions of the Optical Society* is devoted to the methods of specifying and matching colours, and Mr. J. Guild, of the National Physical Laboratory, adds considerably to our knowledge of the theory and technique of the subject by his three papers. The standard method of specifying a colour is by the amount of each of three chosen 'primary colours' which, when mixed together, match the given colour. Mr. Guild points out that so long as the three primary colours produce white when properly mixed, no special significance attaches to the particular colours chosen, but for convenience he uses a red of wave-length 63×10^{-6} cm. obtained by a Wratten No. 71 filter, for the green a wave-length about 54×10^{-6} cm. obtained by a Wratten No. 62, and for the blue a wave-length 45×10^{-6} cm. by a Wratten No. 49 B filter. For colours of high spectral saturation which are not conveniently dealt with by the trichromatic instruments, Mr. Guild has devised a monochromatic plus white colorimeter which retains the advantage of using spectral colours.

Colour Kinematograph Films.—The method of producing colour kinematograph films by the 'Technicolor' process was described by Mr. Leslie Eveleigh at the Royal Photographic Society on March 30 (*British Journal of Photography*, April 9, p. 215). It is a two-colour process, using standard film, and the pictures are projected by the usual standard apparatus. The colour records are taken alternately by means of a camera that has a prism light-divider behind the lens with an orange-red filter for one and blue-green filter for the other, the two images being foot to foot; that is, the images of one colour being erect, while those of the other colour are upside down. A specially exact perforating machine has to be used to ensure a sufficiently perfect registration of the subsequently superimposed pictures. In printing, the negative is shifted two spaces and the positive one, so that only the red sensation pictures are printed, and then, on another film, the blue-sensation pictures are similarly printed. The two positives, before development, are brought back to back, the cementing liquid is sprayed on to them, and by pressure they are firmly cemented together. The compound film is then developed, washed, dried to a tacky condition, and passed over the surfaces of the necessary dye solutions, first one surface being dyed red and then the other surface dyed blue. Excess of the dye solutions is removed by suction, and when dry, both sides are sprayed with varnish, and the protection so afforded is so complete that the final film may be soaked in water for even two hours without damage. The cost is about 3*d*. a foot, while the ordinary monochrome film costs 1½*d*. a foot.

'Creep' in Metals.—Two communications to the recent meeting of the Institute of Metals deal with the subject of 'creep.' R. W. Bailey, from an examination of data obtained by several different investigators, comes to the conclusion that for most, if not all, metals the relation between the time t taken to produce a specified softening of the cold-worked metal and the temperature θ at which it occurs has the form $t = t_0 e^{-b\theta}$, b being of the order of 0·05 for a variety of metals. It is independent of the condition of the metal, but t_0 varies with the condition. The results suggest that creep should not occur under stresses below the elastic limit. H. J. Tapsell and J. Bradley experimenting with a 70 : 30 nickel-copper alloy containing 2·35 per cent. of manganese, find that this alloy, whilst inferior to an alloy of nickel and chromium gives very satisfactory results of mechanical tests at high temperatures. The limiting stress which will produce creep is in these experiments much above the elastic limit, except at high temperatures, but it is of course very difficult to decide whether creep is actually occurring when its amount is small, and experiments may measure rather the accuracy of the apparatus used than the true limiting stress. The alloy gives good impact tests even at 700° C.

Proceedings of the Optical Convention, 1926.

THE exhibition of instruments associated with the Optical Convention having been described in our issue of April 24, while the very entertaining optical illusions arranged by Sir Richard Paget and Dr. R. S. Clay were fully noticed in the lay press, the present article will be devoted to a brief review of some of the papers read during the daily sessions, which occupied two lecture-theatres at the Imperial College of Science and Technology, South Kensington, throughout the week of the Convention. As there were nearly a hundred papers in all, it is impossible to refer here to more than a few of them, but it is understood that the Proceedings of the Convention, containing the complete text, will be published in time to be available at the Oxford meeting of the British Association.

The contribution of outstanding merit was undoubtedly Mr J. Guild's "Survey of Modern Developments in Colorimetry," and the discussion of this and other topics was enhanced in interest by the presence of Mr H. E Ives, of the United States, to whose labours the science of optics is so much indebted. There are few subjects upon which textbook information lags so far behind the available knowledge as the investigation of colour, and it would be difficult to exaggerate the value of this report, which is not less remarkable for its lucidity than for the directness with which it selects for discussion topics which are of greatest practical interest. It was news to many who might be expected to know about such things that the photometry of colours has been put upon such a basis that "the luminosities of different coloured lights can be equated to one another, or added together, in exactly the same way as a gallon of oil can be equated, on a volumetric scale, to a gallon of water, and as the total volume of a gallon of oil added to a gallon of water will measure two gallons"

Various criteria for equality of brightness have been examined, and it has been found that the difficulty which is experienced in judging the equality in brightness of two dissimilarly coloured lights is due to adventitious psychological factors which can be eliminated by statistical methods Simple photometry therefore provides the basis of the modern theory, but flicker photometry can also be used as a derivative method of comparison. The paper deals very thoroughly both with the underlying theory and with the practical methods of colour measurement and specification, and shows that the whole subject is now upon the level of an exact science: colour mixtures can be specified numerically with precision. The terminology is still somewhat confused, however, and the Optical Society, following the example of the corresponding American body, is seeking information by means of a questionnaire with the view of standardising the nomenclature. The author considers that the most pressing need of the science is a statistical standardisation of the chromatic properties of the normal eye. the laws of colour mixture are subject to fluctuations, being slightly different for different individuals, and systematic experiment is necessary to ascertain the norm. The importance of experimenting under standard conditions as to the size of the visual field, the method of illumination, etc, is also insisted upon.

Another interesting paper on this subject was that by Dr. W. Peddie, dealing with the effects of fatigue on the sensations produced by colour mixtures The industrial aspect was brought out in a paper by Mr Gamble, who put forward suggestions for the standardisation of coloured inks for three-colour printing, and one by Dr. S G Barker and Mr H. R. Hirst on the work of the British Research Association for the Woollen and Worsted Industries with regard to the fading of colours.

The use of the photo-electric cell in photometry is an interesting modern development. Dr. N R. Campbell, the originator of the idea, and Mr. M. K. Freeth described an investigation, carried out by this method, of the variations in the properties of tungsten filaments in vacuum lamps. The luminous efficiency of successive samples cut from a single filament is found to vary by several parts in a thousand, and the sensitivity of the method is well illustrated by the present study of this phenomenon. The colour temperatures of the samples are compared by means of a rubidium cell, covered by a filter so as to have nearly the same colour-sensitivity characteristic as the eye, and the electrical magnitudes concerned are carefully measured; an estimated accuracy of 0·05 per cent is achieved, and it is found that more consistent results are obtained if lamps are rated by current instead of by voltage. Mr. T. H. Harrison has extended the method to the measurement of directional candle power, as distinct from the total flux from a lamp The difficulties are considerable owing to the dissimilarity in the characteristics of individual cells and to fatigue effects, but it is claimed that by means of suitable precautions an accuracy better than 0·1 per cent. can be obtained

Among the papers on ophthalmic subjects may be mentioned two, by Mr. O. Aves and Mr. W. Swaine respectively, dealing statistically with the distribution among the population of various defects in eyesight. These papers contain much information on such matters as the age and sex distribution of optical defects, the results obtained by correction, the occupations of the patients, etc. There is a tendency for women to seek the optician's aid at an earlier age than men, possibly on account of their being compelled to do needle-work · in each case the frequency-age curve shows two maxima, one in the early twenties and the other in the later forties. As regards the effect of occupation, sewing and kindred tasks claim by far the largest proportion of victims: half as many of the latter are clerks, and one quarter as many are teachers, students, etc. The subject appears to be a somewhat new one, and the authors express dissatisfaction with the material available. A standardised system of analysis also appears to be desirable.

The subject of optical glass is of great interest for those who are concerned as to the fate of the British optical industry. The matter is of wide importance; the optical industry is intimately related to the security and well-being of the nation, for on this branch of the industry all the others are dependent. It is satisfactory to know that whereas before the War only one British firm was engaged in the manufacture, that number has now been trebled. Mr W. H. Chance and Mr W. M Hampton gave an interesting account of the work of their firm, showing that the number of types of glass which it makes has increased from the pre-War figure of 26 to 112 at the present day. Glass colour filters are made in place of the former gelatine filters: a third colour, distinguishable under all conditions from green and red, has been found for railway signals, enabling home signals to be discriminated from distant signals: 'Crookes' glass has been introduced for excluding ultra-violet radiation, and 'vitaglass' for admitting it The latter has been fitted in the monkey-house at the Gardens of the Zoological Society at Regent's Park, and is said to have had a beneficial effect on the welfare of the inmates; but it seems doubtful whether the indiscriminate use by the public of lamps emitting strong ultra-violet radiation is in any degree safe.

In connexion with the subject of optical glass, considerable interest attaches to a paper by Mr. W. D. Haigh describing a method for determining the absorption coefficient of glass for light passing through it His results for British glass are confirmed by the experience of the National Physical Laboratory, and in view of this confirmation of the accuracy of the method, the author's comparison of the transparencies of British and foreign glasses is of some importance. The British glasses are on the whole considerably more transparent to light of the shorter wave-lengths, and are therefore more suitable for the construction of fast camera lenses. A paper by Lord Rayleigh was devoted to the difference in transparency between silica glasses made from sand and from rock crystal respectively, the comparative opacity of the former being attributable to the presence of bubbles.

A number of papers dealt with instrument design and manufacture, but as this aspect of the Convention has already been described in our columns, no further space need be devoted to it here, except as regards two particularly interesting papers on surveying instruments for the Colonies, by Mr. J. L. Rannie and Col. H St. G Winterbottom respectively. The first of these authors reviewed the requirements of theodolites for use in Canada, reduction in size and weight and increased speed of manipulation being the chief of these. The paper contains some valuable hints to British manufacturers, and suggests the use of aluminium alloys for the metal parts, elimination of counterpoises by suitable design, sacrifice of excessive accuracy, reduction of the number of micrometers, enlargement of the field of view to facilitate rough alignment, and other innovations. Mr. Rannie believes that definite changes along the lines which he suggests are necessary if Great Britain is to hold the Canadian market. Col. Winterbottom, on the other hand, gave an account of the experience of the Indian Survey which was somewhat more flattering to British manufacture: continental instruments fail to stand the rough conditions of transport to India, and the superior workmanship of British-made instruments is much in their favour. Indeed, it would appear from both these papers that British instruments suffer from the disadvantage (from a manufacturer's point of view) that they do not wear out. It is Col. Winterbottom's opinion that British-made instruments are the most economical in the long run, in spite of their initial cost.

C. W H.

The Sense Organs of Insects.

LITTLE is definitely known from the physiological point of view of many of the sense organs of insects Except in the case of the eyes and the tactile hairs, it is largely a matter of conjecture to classify them according to function. It is desirable, therefore, to group the various types of these organs into different categories based upon their essential structure

Most of the sense organs of insects can be classified according to the form of their external cuticular components, as was carried out by Schenk in 1903. Dr. R E. Snodgrass, in a recent valuable contribution entitled "The Morphology of Insect Sense Organs and the Sensory Nervous System" (*Smithsonian Misc. Coll.* 77, No. 8, 1926), follows in the main this same general classification. His paper commends itself to all interested in the subject, since he has brought together the chief results of the great mass of recent German work in a convenient form Dr. Snodgrass points out that, since no sensory cytons have been found in the central ganglia of insects, we have to conclude that they are represented by the sensory cells found in relation with the body-wall and alimentary canal. This fundamental conclusion contrasts with what is known concerning the sensory cytons of the vertebrate nervous system, where they are located in the spinal ganglia Furthermore, the origin and growth of the sensory nerves have not so far been traced in any insects. All we do know is that the sensory nerves of those animals terminate in the central ganglia in finely branching nerve fibrils which constitute the sensory neuropiles.

The simplest type of insect sense organ or sensillum is little more than a slender hair. Histologically it consists of a large hair-forming cell, a membrane cell, which secretes the membrane uniting the hair to its socket, and a sense cell The latter lies beneath the hypodermis and sends out a nerve process to the base of the hair. It seems reasonable to conclude that such tactile hairs were the first specific sense organs to be acquired by insects, and that from them were developed organs for perceiving chemical stimuli, sound stimuli, or whatever other stimuli are perceptible to insects. In the case of the eyes, the fundamental elements in all varieties of these organs among insects are photoreceptive cells of hypodermal origin. These cells correspond with the sense cells of other sense organs and may be termed the sense cells of the ocular sensillum. Associated with them are cells of hypodermal origin which differ greatly from the enveloping cells of the other sense organs This fact leads Dr Snodgrass to conclude that any theory which would derive an ocular sensillum from that of an original sensory hair, as was suggested by Patten in 1890, is too far-fetched to be convincing.

The cuticular part of a sense organ is adapted for the reception of a specific stimulus. In the case of a chemoreceptor the organ is somehow penetrable by odour or taste substances. The idea that such organs were perforated to allow of the substances to be perceived to come in contact with nerve-endings is not upheld. The cuticular walls of these sense organs are, in many cases, not more than half a micron in thickness, and it is reasonable to suppose that they allow of the passage of odour or taste substances. In support of this view Dr. Snodgrass quotes the observation of Vogel, who noted that the membranous cupola of a basiconic sensillum of the wasp is coloured by haematoxylin, and hence is permeable by it. There is no doubt that a better acquaintance with the physiology, the senses, and the tropisms of insects will provide an insight into how these creatures so successfully maintain their dominant place in Nature, notwithstanding man's most energetic efforts to repress them.

A. D. I.

Geophysical Observations in France.

THE third volume of the "Annales" of the Institut de Physique du Globe de l'Université de Paris and of the Bureau Central de Magnétisme Terrestre, the two institutions directed by Prof. Maurain, has been issued recently (Paris: Les Presses Universitaires de France, 1925). The volume is devoted mainly to observations made during the year 1923. The principal geophysical observatory in France is at Val-Joyeux, 24 kilometres west of Paris. For this observatory hourly values of the magnetic elements are published. Systematic magnetic observations have been re-established recently at Nantes on the lower Loire, and the results of the first complete year's work are now given. It appears that, in spite of the disturbance due to electric trams, which come within 450 metres of the Observatory at Nantes, there is satisfactory agreement between the two stations, which are in nearly the same latitude. For the year 1923 the range[1] of the mean diurnal variation of declination was 6·46′ at Val-Joyeux and 6·33′ at Nantes, the corresponding figures for horizontal force were 16γ and 16γ.

Another new departure is the organisation of regular observations of atmospheric electricity at Val-Joyeux. Potential gradient in the open is recorded directly by the method adopted by Norinder in Sweden. A radium collector is suspended about 2 metres above ground in the middle of a wire 16 metres long, and the potential is shown by a Benndorf electrograph. The difficulty in such operations, a difficulty which has made many old records of atmospheric potential useless, is to ensure good insulation. In the present instance there is no provision for warming the hut, so that the deposit of moisture on cold nights would seem to be inevitable. It is therefore to be regretted that there is nothing in M. Salles's account of the work at Val-Joyeux to show what control observations are made. The conclusions as to the average potential gradient must be accepted with some reserve; as the figures stand, they suggest that the atmosphere at Val-Joyeux is much purer than that at Kew. For Val-Joyeux the average gradients in June and December 1923 are given as 65 volts and 123 volts per metre respectively. According to Chree, the averages for Kew (covering 1898–1912) are 207 volts in June and 409 volts in December.

A résumé of the observations made with the Ångström pyrheliometer at Parc St. Maur from 1907 to 1923 is given by M. Brazier. The brightest sunshine observed was on March 26, 1915, 1·44 calories per square centimetre per minute.[2] The 'solar constant' being 1·94, nearly 75 per cent. of the solar energy was getting through the atmosphere on that occasion. The highest transmission coefficient (estimated for a vertical sun) was recorded in December, 87 per cent., whereas in the summer months no co-efficient was estimated as more than 76 per cent. This contrast is attributed to the stopping power of the excess of water vapour in the summer air.

Several sections of the volume are devoted to accounts of parts of the magnetic survey of France. The previous survey was in 1896. The interval is large enough for a diminution of declination by 3°. There is some indication of local peculiarities, but the discussion of these is reserved until the completion of the survey.

Mention must also be made of a series of articles co-ordinating all available information as to magnetic surveys of French dependencies. In the present volume maps of Indo-China and Madagascar are reproduced. The latter map is remarkable for the complexity of the lines in the centre of the island. The geological significance of the contortions has been worked out by the director of the Tananarive Observatory. These articles by Mlle. Homery will be very useful for reference.

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[1] In each case the figure quoted is the difference between the highest and lowest of the mean hourly values for the year.

[2] The reading has been adjusted to the Smithsonian scale; the date is misquoted in the table on p. 137.

Ethnic Relations in India and the Near East.

IN a paper read before the Royal Anthropological Institute (Indian Section) on April 30 on this subject, Mr. L. H. Dudley Buxton stated that the three great regions of the eastern Mediterranean, Mesopotamia, and India have been the mothers of civilisations on which to a greater or lesser degree our own civilisations are based. In them also have arisen the three great religions of the world, Christianity, Mohammedanism, and Buddhism. Superficially their inhabitants seem to be very unlike, but a closer examination reveals many traits in common, both with each other and with the people of western Europe.

Excluding the Mongoloid peoples, who are really intruders into this region, though their arrival was probably far back in the past, we have two great groups, roundheads and longheads. Both types are found even in the earliest graves excavated up to the present. Any race which is composed of both longheads and roundheads shows considerable variety, as might be expected, both types appearing in the mixed race in each generation.

Such a mixture was found in the earliest graves so far excavated at Kish in Mesopotamia, and still continues. In India the rounder the heads of each group of people examined the more variable they are, but in the Near and Middle East the least variable are the extreme longheads and the extreme roundheads. This suggests that in India we have basic stocks who are longheads and roundheaded intruders; whereas westwards we have both types represented in a pure as well as a mixed state.

Further analysis shows that in the Near East there is a type akin to Stone Age man, such as 'Combe Capelle.' This type is probably also represented in India. There are even suggestions that a more primitive type lingered on in prehistoric times well after the Stone Age. The second type of longheads is akin to the well-known Mediterranean man. This or a kindred type is also found in India. But here we have also a more primitive type, probably specialised for life in the tropics, and akin to the very primitive Australian aboriginal. Whether this type ever occurred in the Near East is uncertain. The roundheads which are intruders in India are dominant in much of the Near East, but never succeeded in becoming more than an element in the population of the Middle East, although they can be found in units almost everywhere there.

All this elaborate racial mixing probably took place at a remote period, long before the dawn of history, and it seems difficult to identify any physical type with any known historical people. Civilisations have come and gone, especially in the land of the two rivers, but always the physical type of the people seems much the same. It is to be hoped, therefore, that some lucky chance will give us graves at the very beginning of the Bronze Age or before, so that the actual date of the invasions of the roundheads and of the later comers among the longheads may be traced.

University and Educational Intelligence.

BIRMINGHAM.—Sir Oliver Lodge will deliver the Huxley Lecture on Tuesday, May 4, at 5.30 P.M., his subject being "Difficulties about the Ether."

CAMBRIDGE.—Certain regulations which are to take effect as ordinances on the commencement of the new statutes have been promulgated. Among these are the regulations for the committee which is to superintend the Natural Sciences Tripos. There are always present among the senior members of the University a certain number who are dissatisfied with the Tripos; these will now be able to bring their theories to the notice of an official body constituted for the purpose. It is not improbable that this committee, which now seems a simple innovation, will occasionally prove to be a storm-centre of wordy warfare.

Sir John Russell and some of the staff of the Rothamsted Experimental Station are again giving a course of public lectures on the chemistry, physics, and biology of the soil. Last year the course attracted considerable attention and was an undoubted success. The lectures are being given on Tuesdays, Wednesdays, and Thursdays, at 2.15 P.M.

The Board of Research Studies has presented its annual report; the total number of registered research students shows a slight increase, for which mathematics and geology are mainly responsible. It is satisfactory to note that graduates of the University are now registering as students for the doctorate of philosophy more frequently than formerly. At present, of a total of 276 research students, 90 are from Cambridge, 89 from other universities of the British Isles, 44 from the colonies, and 37 from the United States.

An appointment will be made towards the beginning of July next to a Busk Studentship in Aeronautics. The studentship is of the value of about 150*l*., tenable for one year from October 1, and is open to any man or woman being a British subject and of British descent who has not attained the age of twenty-five years on that date. The holder of the studentship will be expected to engage in research in aeronautics, and specially in subjects such as stability problems, meteorological questions bearing on flight, or the investigation of gusts, treated either experimentally or mathematically, in which the late Edward Busk was specially interested. Forms of application can be obtained from Prof. B. Melvill Jones, Engineering Laboratory, Cambridge, and must be returned not later than May 12.

GLASGOW.—Dr. R. H. Thouless, fellow of Corpus Christi College, Cambridge, Arnold Gerstenberg and Burney student and prizeman, senior lecturer in psychology at the Victoria University of Manchester, has been appointed lecturer and head of the department and laboratory of psychology in the University, in succession to the late Dr. Watt.

A memorial lectureship and medal have been founded in the University in commemoration of the late Prof. Sir William Macewen, F.R.S. The lectureship will be biennial, and the memorial lecture will deal with advances in surgery. The first memorial lecture will be given in 1927 by a distinguished surgeon unconnected with Glasgow. The memorial medal will be awarded annually to the most distinguished candidate in the final or qualifying examinations in surgery of the year.

LONDON.—The following courses of free public lectures are announced: At the Imperial College of Science and Technology—Royal School of Mines—at 5.15 on May 3, 10, and 17, "Past Ice Ages of the World, and their Control of Animal and Plant Life, with special reference to the Australian Evidence," by Sir T. W. Edgeworth David; at King's College, at 4.30 on May 25, June 1, 8, and 15, "The Constituents and Coagulation of Blood Plasma," by Dr. J. W. Pickering; and at University College at 5.30 on May 27, 28, and 31, "The New Aspect on Strong Electrolytes," by Prof. Niels Bjerrum (of the University of Copenhagen). No tickets will be required for either course.

THERE will be an election to junior Beit Memorial Fellowships for medical research in July, and applications for the fellowships are invited. The annual value of each is 350*l*. and the tenure usually three years. The latest date for the return of application forms (which should be sent to Sir James K. Fowler, 35 Clarges Street, W.1) is June 1.

THE Council of the London (Royal Free Hospital) School of Medicine for Women invites applications for the Dr. Edith Pechey Phipson post-graduate scholarship of 100*l*. a year for not more than three years. The scholarship is open to all medical women, preferably coming from India, or going to work in India, for assistance in post-graduate study. Applications must be sent to reach the Warden and Secretary of the school, 8 Hunter Street, W.C.1, by May 31.

THE Oxford and Cambridge Appointments Boards have published reports for the year 1925 showing that the appointments obtained during the year by their candidates numbered 210 and 399 respectively. The former are classified as Government 42, educational 59, business and industrial 32, journalistic, secretarial, etc., 10, and temporary 67; the latter as Government departments (mainly scientific) 16, administrative posts in commerce and industry 81, manufacturing and technical 89, Colonial administration 37, agriculture and forestry 11, Indian and Colonial railways 16, railway traffic 4, journalism and publicity 2, publishing 2, articled clerkships 6, museums 2, architecture 1, medical 2, secretaryships 6, educational 119, miscellaneous 5. The Cambridge report says that engineering students were readily placed. Many opportunities exist for engineers with a knowledge of chemistry, or chemists with a knowledge of engineering, but candidates properly equipped on both these sides are very few. More physical chemists could have been placed. The number of candidates who registered for the first time during 1925 was 582 at Cambridge and 473 at Oxford.

HULME HALL, Manchester, announces that an examination will be held in the second week of May for Entrance Scholarships. An interesting feature of the entrance conditions prescribed alike for scholarship candidates and other candidates for admission except advanced students is a test of their "alertness, intelligence, and intellectual outlook, their personal qualities of mind and mental equipment, and their mastery of the modern standard English dialect." The test is conducted by means of a paper of general questions—historical, scientific, economic, social, political, geographical, literary, artistic, and ethical—and a *viva voce* examination, including the reading aloud of passages of English prose. The total amount of an undergraduate's annual expenditure while a member of the Hall, exclusive only of university fees (15*l*. to 40*l*. according to faculty), clothing, vacation and travelling expenses, is shown by recent inquiries among the students to average 107*l*. The Hall aims at reproducing the best features of college life at Oxford or Cambridge, an excellent summary of which is given in a leaflet circulated with its prospectus entitled "University Life: Residence in Hall or Not?"

Contemporary Birthdays.

May 1, 1852.	Prof Ramón y Cajal, For.Mem. R.S
May 1, 1866.	Sir A. Trevor Dawson, Bart., M Inst.C E.
May 1, 1858.	David Hooper, LL D.
May 2, 1868.	Prof Robert W. Wood, For Mem.R.S
May 5, 1882.	Sir Douglas Mawson, F.R.S.
May 5, 1860.	Dr Charles Chree, F.R.S.
May 6, 1866.	Sir Murdoch Macdonald, M.Inst C E.
May 6, 1848.	Dr. H. R. Procter, F.R.S.
May 7, 1863.	Sir John Rose Bradford, F R S.

Prof. RAMÓN Y CAJAL, the eminent physiologist, was born at Petilla, Spain He was Nobel laureate (with Golgi) in 1906.

Sir TREVOR DAWSON received his technical training at the Royal Naval institutions at Gosport and Greenwich. He is the inventor and constructor of many improvements relating to artillery. Sometime experimental officer to the Home Office Committee for the investigation of gas cylinders, he is a past president of the Junior Institution of Engineers.

Dr HOOPER, an authority in pharmacology and economic botany, was born at Redhill. Quinologist to the Government of Madras from 1884 to 1897, he was afterwards, before returning to England, curator of the Industrial Section of the Indian Museum, Calcutta.

Prof WOOD was born at Concord, Mass. Educated at Harvard, Johns Hopkins, and Berlin, from a post at the University of Wisconsin, he became (1901) professor of experimental physics in Johns Hopkins University, Baltimore He is specially identified with researches in optical science, in which he has shown experimental skill of a high order.

Sir DOUGLAS MAWSON is a graduate of the University of Sydney. He was born at Bradford, Yorkshire. His pioneering work in Antarctic exploration is well known. He was with Sir Ernest Shackleton in his southern expedition of 1907, and he was leader of the Australian Antarctic Expedition, 1911–14. The Royal Geographical Society awarded him its Antarctic medal in 1909, and its distinction of the Founder's medal in 1915. The president of the Geological Society (Mr Lamplugh) in handing Sir Douglas the Bigsby medal in 1919, referred to his arduous geological researches in the New Hebrides, in the Broken-Hill district, and in other regions in Australia, as well as the systematic study of Australasian minerals, in themselves a full measure of achievement.

Dr CHREE, who, after attending the Grammar School, Old Aberdeen, proceeded thence to the University of Aberdeen and afterwards to Cambridge, becoming, at the latter university, sixth wrangler. Until 1925 he was, for more than thirty years, superintendent of Kew Observatory, Richmond The relationship between solar manifestations and terrestrial magnetism has specially engaged his attention. In 1919 Dr Chree was Hughes medallist of the Royal Society.

Sir MURDOCH MACDONALD, following extensive constructional railway work in Scotland, engaged for many years in engineering schemes under the Public Works Ministry of Egypt

Sir JOHN ROSE BRADFORD, who is a Londoner, was educated at University College School. A former secretary of the Royal Society, he was recently elected president of the Royal College of Physicians.

Societies and Academies.

LONDON.

Society of Public Analysts, April 7.—H Droop Richmond and J. A. **Eggleston**: The analysis of Acetic anhydride By adding 2 c.c. of acetic anhydride to 200 c c of a mixture of 94 parts of toluene and 6 parts of aniline, and measuring the rise of temperature produced in the reaction, a determination of the strength of the acetic anhydride can be made with an accuracy comparable to that of the method of Henschutkin and Wasilieff. In very accurate work a correction is necessary for the heat evolved in the formation of aniline acetate —H Droop Richmond and Eric H **England**: The analysis of glacial acetic acid. Acetic acid is almost unique in that specific gravity falls with increasing percentage, whilst the freezing point rises Impurities, of which propionic acid is the most important, lower both specific gravity and freezing point. By calculating the specific gravity equivalent to the freezing point and subtracting from it the specific gravity found, a close approximation to the percentage of propionic acid can be obtained by dividing by 0·00135 Other impurities are aldehydes and ketones, probably chiefly propionaldehyde and homolgues —J. F. **Tocher** (1) Errors of judgment in chemical analysis. In experiments on the titration of sodium hydroxide solution with N-sulphuric acid, the mean results of successive determinations during a forenoon were of a periodic character. On an average the first two determinations were less trustworthy than the others. The variations in the personal equations of observers were independent of the apparatus and the material.—(2) Variations in the composition of milk. The percentage of butter fat tends to decrease slightly with increasing yield per milking for a particular animal, but the total amount of butter fat (and also of solids not fat) increases proportionally with increased yield. —E. R. **Bolton** and K. A. **Williams**: A test for Tung oil. Previous attempts to obtain a definite and constant petroleum spirit extract of unpolymerised matter from the residue of Worstall's test have failed owing to incomplete and uncontrolled polymerisation A definite yield of extract varying between narrow limits can be obtained under proper conditions, and adulterants are readily disclosed by the yield of extract in excess of the standard amount Most of the oils likely to be used as adulterants are completely recovered in the extract; linseed oil being an exception, in which case approximately 50 per cent. is retained in the polymerised mass

Royal Meteorological Society, April 21.—J **Glasspoole**: The driest and wettest years at individual stations in the British Isles, 1868–1924. The data have been obtained for some 250 long-period stations distributed over the British Isles as regards the driest and wettest years Thus for Camden Square (London): average annual rainfall, 24·47 in; driest year 1921, with 14·60 in. or 60 per cent of the average, wettest year 1903, with 38·10 in. or 156 per cent of the average The years 1887 and 1921 were the driest years in the series 1868–1924 over 40 and 31 per cent. of the British Isles, and the years 1872 and 1903 were the wettest years over 49 and 19 per cent. of the whole British Isles respectively. Almost every year was the driest or the wettest for one place or another in these islands.—C. E. P **Brooks**: (1) The meteorological conditions during the glaciation of the present tropics, being some remarks on the climatological basis of Wegener's theory of continental drift. The reconstruction of Permo-

Carboniferous geography given by Wegener shows a large continent formed by the union of South America, Africa, India, Australia, and Antarctica, surrounding the south pole and bearing extensive ice-sheets, while the equator passed through Europe and the United States. Recent researches have shown, however, that in the latter country also there were a number of powerful glaciers extending to sea-level. Thus there are the same climatic objections to Wegener's reconstruction as to that based on the present positions of the continents. The reconstruction of the Upper Carboniferous given by Th. Arldt ("Handbuch der Palæogeographie") is accordingly taken as a basis, and the probable distribution of warm and of cold ocean currents and of winds is discussed. A warm current would traverse the region of the coal-measures, and the American glaciation is also readily explicable owing to the neighbourhood of an arm of the Arctic Ocean, while even the glaciation of the tropics may not be a vital objection.—(2) The variation of pressure from month to month in the region of the British Isles A chart of the deviation of means of pressure from normal in any month usually shows 'centres' of maximum excess or maximum deficit. Centres of excess of pressure tend to move along fairly well-defined tracks and generally from west to east. The main track runs from Alaska south-eastward to the centre of the United States, then eastward to the Azores, north-eastward to the British Isles or Scandinavia, and again eastward to northern Russia or the Kara Sea. This would take about six months, though no single centre was found which persisted long enough to make the whole journey. Centres of deficit are more variable in their movements, but also tend to move from west to east.

Dublin.

Royal Dublin Society, March 23.—W. E. **Adeney**: On the rate and mechanism of the aeration of water under open-air conditions. The bubble method employed by Adeney and Becker for the investigation of the process and rates of solution of atmospheric nitrogen and oxygen by fresh and salt waters, affords a means of determining the rates of solution of these gases, when every part of the water is successively exposed to them in thin films, and becomes gradually and completely aerated independently of evaporation or of downward 'streaming'. The aeration of quiescent bodies of fresh water by downward 'streaming' may take place 113, 56, 245, and 185 times slower than the initial rate of solution of the surface film 0·05 cm. thick, according to the humidity of the air passing over their undisturbed surfaces. When, however, the surface of the water is kept in a continuous state of turbulent agitation, as in a bio-aeration tank for the purification of sewage liquors, the effective area of water exposed to the air becomes so much increased that the downward 'streaming' is greatly augmented, and the rate of aeration of the water may become equal to, or even exceed, that calculated from the rates of solution found by the bubble experiments for films 0·05 cm. thick, for the given depth of the water, assuming the exposed surface to remain in an undisturbed condition.—J **Bell**: The constitution of dicyanodiamide. In Bamberger's experiments on the action of nascent hydrogen on dicyanodiamide, hydrolysis to dicyanodiamidine takes place to the extent of 50 per cent. A mercury derivative of dicyanodiamide is also described.—J. **Doyle** and Miss P. **Clinch**: The pentosan theory of cold-resistance applied to conifers. The pentosans of conifers can be classed in three groups: (*a*) water-soluble pentosans, (*b*) pentosans subsequently extractable with 1 per cent. hydrochloric acid, and (*c*) pentosans still remaining and only extractable with 12 per cent. hydrochloric acid. All three classes vary considerably throughout the year, though not independently, the variation in classes (*a*) and (*b*) being reciprocal. Cupressus is remarkable in having a very high winter content of water-soluble pentosan, this class being usually present in minimum quantity during the winter months. The H-ion concentration of conifer leaves shows little seasonal variation. The leaves are distinctly acid—from *p*H 3 to 4. Cupressus is distinctly less acid than the other forms examined. No relations, seasonal or otherwise, can be established between hardiness in conifers and pentosan content.

Paris.

Academy of Sciences, March 29.—Paul **Appell**: Some formulæ relating to Euler's constant, C.—F. E. **Fournier**: General expressions of the resistance, R, of water to the translation of hulls, at all possible velocities —M. **Brillouin**: Is the moon radioactive? The hypothesis that the moon is radioactive is regarded as probable, and this radioactivity may exert a sensible action upon the earth's outer atmosphere.— — **d'Arsonval** and F. **Bordas**: The determination of the impurities in the atmosphere. Some results obtained with a modified Owens gauge in the centre of Paris —Paul **Sabatier** and J. F **Durand**: An attempt at the catalytic hydrogenation of ethylene oxide. Ethylene oxide mixed with hydrogen and passed over reduced nickel heated to 125° to 150° C. is not reduced, but is converted into acetaldehyde and condensation products of the latter.—R **Maire**: The vegetation of south-west Morocco.—Émile Forgue was elected a corresponding member for the Section of Medicine and Surgery in succession to the late M. Depage.—Walter **Saxer**: The exceptional values of the successive derivatives of meromorph functions.—I. **Karamata**: Certain limits connected with Stieltjes integrals.—Paul **Lévy**. Remarks on the methods of summation of divergent series — — **Hadamard**: Remarks on the two preceding communications —Leonida **Tonelli**: The integration of suites of functions capable of summation —Louis **Roy**: The dynamic adiabatic law relating to elastic lines — — **Amans**: The aerodynamics of windmills.—Jean Jacques **Trillat**: Researches on the phenomena of lubrication by means of X-ray spectrography. The X-ray spectra prove that as the result of friction between two surfaces the fatty layer is stratified —Michel O. **Samsoen**: The crystallisation of glycerol. In the course of some experiments on the change in the coefficient of expansion of glycerol in the neighbourhood of −62° C., it was noticed that on warming up, the glycerol always crystallised spontaneously, centres of crystallisation commencing to appear about −23° C. Unless the prolonged preliminary cooling has been carried below −40° C., crystallisation does not take place —John H. **Shaxby**: Formulæ relating to the density of a fluid and the molecular diameter —Henri **George**: The manufacture of transparent quartz glass. The difficulty of freeing fused silica from gas bubbles is well known. The author has found that a transparent fused silica glass, free from bubbles, can be obtained by simple fusion in a crucible of certain natural quartzites. These quartzites are of high purity (99·9 per cent. silica) and there are no gaseous inclusions.—J. **Hugounenq** and J. **Loiseleur**: The use of glycogen in the preparation of colloidal metals. Colloidal solution of many metals may be prepared by means of glycogen, which behaves both as stabiliser and reducer. Details are given of the preparation of colloidal silver, mercury and bismuth.—Charles **Prévost**: The catalytic dehydration of the vinylalkylcarbinols. Ethylvinylcarbinol, dehydrated by the catalytic action of alumina at 350°-365° C., gives a 60 per cent to 70 per cent yield of 1·3 pentadiene.—Ch. **Courtot** and J. **Bonnet**: Contribution to the study of the π of sulphonation.—E. **Delcambre**, P. **Idrac** and F. **Geoffre**: A new temperature and pressure recorder for the study of the higher atmosphere.—P. L. **Mercanton**: The magnetisation of the Greenland basalts.—G. **Mangenot**: The existence of a remarkable functional arrangement in the orifices of the liber sieves.—V. G. **Korneff**: Measurement of the force of suction of the soil for water.—C. **Rouppert** and H. **Jedrzejowski**: The action of the radiation of radioactive bodies on plant pearls.—H. **Hérissey**: The detection of asperuloside in plants. The extraction of this glucoside from *Galium Aparine*.—Theodor **Lipmaa**: The physical and chemical properties of rhodoxanthine.—R. **Fosse**: A new natural principle in plants: allantoic acid.—E. **Roubaud** and J. **Colas-Belcour**: The obligatory winter sleep and its various manifestations in mosquitoes indigenous to France.—**Gruvel**: The development of trout culture in Morocco.—J. **Sabrazès**: The simple and rapid coloration of the treponeme of syphilis. The comparative affinity for stains of the Spirochætes.

ROME

Royal Academy of the Lincei, February 21.—V. **Volterra**: Variations and fluctuations in the number of individuals in animal species living together.—O. M. **Corbino**: Magneto-optic phenomena in fields which are varying rapidly. Theory predicts that the Zeeman phenomenon should respond instantaneously to the changes of a field varying with the time according to any law and with any rapidity. In carbon disulphide the magnetic rotatory dispersion follows quantitatively the oscillations of a high-frequency field as far as the shortest persistent waves (300 metres) with which it was found possible to experiment.—Ferruccio **Zambonini** and S. **Restaino**: Double sulphates of rare earth and alkaline earth metals (v.). Cerous ammonium sulphate. The crystallographic and other characters of the two compounds, $Ce_2(SO_4)_3$, $(NH_4)_2SO_4$, $8H_2O$, and $Ce_2(SO_4)_3$, $5(NH_4)_2SO_4$, are described.—Umberto **Cisotti**: Resolution of harmonic problems in a plane area of indefinite extent with *n* circular gaps of small diameter.—Azeglio **Bemporad**: A new method of studying experimental results. The method recently described by Cantone has been applied to the results of astronomical measurements, and is closely analogous to the hodograph so frequently used in mechanics and other branches of mathematics.—G. **Vranceanu**: The integration of the problem of two bodies in the case in which the mass is a linear function of the time.—Emilio **Adinolfi**: The absorption spectrum of potassium and calcium permanganates.—Washington Del **Regno**: The behaviour of selenium subjected to the action of mesothorium radiations. Exposure of selenium to mesothorium radiation produces a marked variation in the electrical resistance of this element, the effect being due mostly to the β-rays.—G. **Carobbi**: The chemical composition of the orthite of Ambatolotsikely (Madagascar).—Pia **Gravino**: The antimonite of Wolfsberg (Harz).—G. R. **Levi** and R. **Haardt**: The catalytic action of metals of the platinum group and their degree of subdivision (ii.). The results already published, together with those now obtained with palladium, rhodium, iridium, ruthenium, and osmium show that, in the form of 'black,' these metals are so highly subdivided that the granules are comparable with those of colloidal metals. Measurements of the X-ray diagrams show that, within moderately wide limits, the dimensions of the granules depend on the method of preparation as well as on the nature of the metal. The fact that the granules of the spongy metals are large in comparison with those of the 'blacks' explains the practical advantage of subdividing the catalyst on a diluent material, such as asbestos or porcelain.—A. **Ferrari**: Rontgenographic investigation of the crystalline lattices of manganous fluoride and manganese dioxide. Manganous fluoride crystallises in the tetragonal system, the axial ratio being $c:a=0·675$. Its structure is of the rutile type, the dimensions of the elementary cell which contains two molecules being $a=4·865$ and $c=3·284$ Å.U.; the calculated and observed values of the density are respectively 3·97 and 3·98. The dioxide exhibits the same lattice as the fluoride, the dimensions being $a=4·380$ and $c=2·856$ Å.U., the calculated specific gravity is 5·27, whereas the experimental value is 5·08, and the axial ratio, $c:a=0·625$, is decidedly lower than that found crystallographically, namely, 0·664. The dioxide exists in only one crystalline form.—Enrico **Carozzi**: A chromiferous spessartite from St. Barthélemy (Valle d'Aosta).—Arnaldo **Masotti**: Uniform rotation of a solid cylinder in an indefinite perfect liquid. Extension of Kutta and Joukowski's theorem.

Official Publications Received.

Classified List of Smithsonian Publications available for Distribution, March 15, 1926. Compiled by Helen Munroe. (Publication 2806.) Pp. v+80. (Washington, D.C.: Smithsonian Institution.) [Corrected entry.]

Engineering Abstracts from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Published by the Institution of Civil Engineers with the Cooperation of other Engineering Societies in Great Britain and the Dominions. New Series, Nos. 26 and 27, January and April 1926. Pp. 150. (London: Institution of Civil Engineers.)

Agricultural Research Institute, Pusa. Bulletin No. 164: Standard Methods of Analysis of Fertilizers. By Dr. J. Sen. Pp. iii+14. (Calcutta: Government of India Central Publication Branch.) 4 annas, 6d.

Memoirs of the Indian Meteorological Department. Vol. 24, Part 11: Rainfall Types in India in the Cold Weather Period, December 1 to March 15. By Sir Gilbert T. Walker and Dr. J. C. Kameswara Rav. Pp. 317-354. (Calcutta: Government of India Central Publication Branch.) 4 annas, 5d.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 312: Terrestrial Magnetism; Results of Magnetic Observations made by the United States Coast and Geodetic Survey in 1924. By Daniel L. Hazard. (Special Publication No. 116.) Pp. 50. (Washington, D.C.: Government Printing Office.) 10 cents.

Journal of the Indian Institute of Science. Vol. 8A, Part 16: The Occurrence of Sylvestrene. By B. Sanjiva Rao and John Lionel Simonsen. Pp. 287-294. 8 annas. Vol. 9A, Part 1: Contributions to the Scientific Study of the Lac Industry. Part xi.: Early Recognition of Sex among Lac Insects. By S. Mahdihassan. Pp. 24+10 plates. 4 rupees. (Bangalore.)

Department of Commerce: Bureau of Standards. Circular of the Bureau of Standards, No. 279: Relations between the Temperatures, Pressures and Densities of Gases. Pp. 86. 25 cents. Circular of the Bureau of Standards, No. 300: Architectural Acoustics. Pp. 9. 5 cents. (Washington, D.C.: Government Printing Office.)

Bulletin of the American Museum of Natural History. Vol. 56, Art. 1: The Hemicyoninæ and an American Tertiary Bear. By Childs Frick. Pp. 119. (New York.)

Papers and Proceedings of the Royal Society of Tasmania for the Year 1925. Pp. v+252+xiv+19-36+24 plates. (Hobart.) 10s.

Department of Commercial Intelligence and Statistics, India. Agricultural Statistics of India, 1923–24. Vol. 1: Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, Land Revenue Assessment and Harvest Prices in British India. Pp. xi+81+7 plates. (Calcutta: Government of India Central Publication Branch.) 1 rupee, 1s. 9d.

Year-Book of the Department of Agriculture, Ceylon, 1926. Pp. iv+62+22 plates. (Peradeniya.)

Transactions of the Royal Society of Edinburgh. Vol. 54, Part 2, No. 10: Geology of the Outer Hebrides. Part iii.: North Uist and Benbecula. By Prof. T. J. Jehu and R. M. Craig. Pp. 467-489+4 plates. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 4s. 6d.

Diary of Societies.

SATURDAY, MAY 1.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Eastern District) (at Grand Hotel, Margate), at 1.—H. A. Borg and others: Discussion on Notes on Municipal Work at Margate.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. P. C. Buck: The Song Form in England as represented by Stanford.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—Annual Meeting.

MONDAY, May 3.

Cambridge Philosophical Society (in Cavendish Laboratory), at 4.30.—Prof. Sir J. Larmor: Insular Gravity and Oceanic Isostasy.—W. A. D. Rudge: A Mechanical Model of the Rutherford-Bohr Atom.—Miss C. A. Scott: On the Higher Singularities of Plane Algebraic Curves.—*Communicated by title only*:—Ž. Marković: Sur la non-existence simultanée de deux fonctions de Mathieu.—C. G. F. James: On the Multiple Tangents and Multisecants of Scrolls in Higher Space.—E. V. Appleton: On the Diurnal Variation of Ultra-short Wave Wireless Transmission.—R. Vaidyanathaswamy: The (2, 1) Correspondence.

Royal Institution of Great Britain, at 5.—General Meeting.

Society of Engineers (in Demonstration Room of the Science Museum, South Kensington), at 5.30.—H. W. Dickinson: Landmarks in the History of Prime Movers.

Institution of Electrical Engineers (Western Centre) (at Chamber of Commerce, Swansea), at 6.—Prof. S P. Smith: An All-Electric House.

Aristotelian Society (at University of London Club), at 8.—Prof A E. Heath: Objectivity in Science.

Royal Society of Arts, at 8.—C. R. Peers: Ornament in Britain (Cantor Lectures) (3).

Society of Chemical Industry (London Section) (Annual and Ordinary Meetings), at 8.—S. Dickson and R H. H. Stanger: Discussion on Modern Portland Cement Manufacture.

Royal Society of Medicine (Social Evening), at 9.30.—Sir Humphry Rolleston: Some Worthies of the Cambridge Medical School (Address).

TUESDAY, May 4.

Royal Society of Arts (Dominions and Colonies Section), at 4.30.—C. Ponsonby: Nyasaland.

Royal Institution of Great Britain, at 5.15.—Prof. J. Barcroft: Organs of Multiple Function (4): Lungs

Royal Society of Medicine (Orthopædics Section), at 5.30.—Annual General Meeting.

Institute of Marine Engineers, at 6.30.—J. A. Aiton: Steam Pipes for Super-High Pressure.

Röntgen Society (at British Institute of Radiology), at 8 15.

Royal Anthropological Institute, at 8.30.—Rev P. Schebesta: The Semang (Negrito Aborigines) of the Malay Peninsula.

WEDNESDAY, May 5.

Geological Society of London, at 5.30.—R. M. Jehu: The Geology of the District around Towyn and Abergynolwen (Merioneth).—K. A. Davies: The Geology of the Country between Drygarn and Abergwesyn (Breconshire).

Institution of Electrical Engineers (Wireless Section), at 6.—Dr. R. L. Smith-Rose and R. H. Barfield: On the Cause and Elimination of Night Errors in Radio Direction Finding.

Society of Public Analysts and other Analytical Chemists (at Chemical Society), at 8.—A Chaston Chapman: The Detection and Determination of Glycerin in Tobacco.—H. Toms. Further Notes on the Crystalline Bromides of Linseed and other Oils.—A. Bakke and P. Henegger: The Polarimetric Determination of Sucrose in Condensed Milk.—H. L Smith and J. H Cooke: The Determination of very small Quantities of Iron.—Dr W. R Schoeller: The Separation of Iridium from Iron.—Jitendra Nath Rakshit: The Determination of Total Alkaloids, Sugar and Oily Substances in Opium.

Royal Society of Arts, at 8.—C. F. Elwell. Radio: Its Past, Present, and Future.

Royal Society of Medicine (Surgery Section), at 8.30.—Annual General Meeting.—Dr. W. E. Gye: The Origin of Tumours.

Royal Microscopical Society (Biological Section)

THURSDAY, May 6.

Iron and Steel Institute (Annual Meeting) (at Institution of Civil Engineers), at 10 a.m.—Presentation of Bessemer Gold Medal to Sir Hugh Bell, Bart.—Sir W. Peter Rylands: Presidential Address.—Report on Heterogeneity of Steel Ingots. By a Sub-Committee of Committee No. 5, consisting of Dr. W. H. Hatfield, T. P. Colclough, W. J. Dawson, J. H. S. Dickenson, A. P. Hague, E. F. Law, S. A. Main, T. M Service, and J. H. Whiteley.—J. H. S. Dickenson: A Note on the Distribution of Silicates in Steel Ingots.—J. H. Whiteley Ghost Lines and Banded Structure of Rolled and Forged Mild Steels.—At 2.30.—W. H. Dearden and C. Benedicks: Magnetic Changes in Iron and Steel below 400° C.

Royal Society, at 4.30.—Prof. A S. Eddington: Diffuse Matter in Interstellar Space (Bakerian Lecture)

Royal Society of Arts, at 4.30.—Sir Frank Baines: Preservation of Ancient Cottages.

Linnean Society of London, at 5.—Capt. J. G. Dollman: Exhibition of a supposed new 'Mutation' in the Rabbit.—Dr. A. W Hill: The Genus Lilæopsis.—R. D'O Good: The Genus Empetrum.—J. T. Cunningham: On the Nuptial Pads of Frogs and Toads.

Institute of Pathology and Research (St. Mary's Hospital, W.2), at 5.—Prof. J Barcroft: Recent Work on the Spleen (Lecture).

Royal Institution of Great Britain, at 5.15.—Sir William Bragg: The Imperfect Crystallisation of Common Things (2).

Institution of Electrical Engineers, at 6.—Annual General Meeting.

Institution of Automobile Engineers (Derby Graduates' Meeting) (at Cavendish Café, Derby), at 7.30.—J. Topham: Inspection in the Building of an Automobile Chassis

Institution of Structural Engineers, at 7.45.—Annual General Meeting.—At 8.—Major J. Petrie: Some Lessons from Practical Experience, with Special Reference to Structural Work on Railways.

Chemical Society, at 8.—Dr. C K. Ingold, E. Holmes, and E. H. Ingold: The Nature of the Alternating Effect in Carbon Chains. Parts IV., V., VI., and VII.—Dr. C. K. Ingold, C. W. Shoppee, and J. F. Thorpe: The Mechanism of Tautomeric Interchange and the Effect of Structure on Mobility and Equilibrium. Part I. The Three-Carbon System.—K. E. Cooper, Dr C. K. Ingold, and E. H. Ingold: The Correlation of Additive Reactions with Tautomeric Interchange. Part V. The Structural Conditions Affecting Mobility and Equilibrium.

Royal Society of Medicine (Obstetrics and Gynæcology Section), at 8.—Annual General Meeting.

FRIDAY, May 7.

Iron and Steel Institute (Annual Meeting) (at Institution of Civil Engineers), at 10 a.m.—Announcement of the Award of the Andrew Carnegie Research Scholarships for 1926-7.—D. Brownlie: Coal Blending.—W. W. Hollings: Notes on the 'Combustibility' of Coke, and Direct Reduction in the Blast Furnace.—Dr. W. Rosenhain, R. G. Batson, and N. P. Tucker: Effect of Mass in the Heat Treatment of Nickel Steel.—G. R. Woodvine and A. L. Roberts: Influence of Segregation on the Corrosion of Boiler Tubes and Superheaters.—At 2.30.—I. G. Slater and T. H. Turner: The Hardness of Carbon Steels at High Temperatures.—A. R. Page: The Hardening and Tempering of High Speed Steel.—A E Cameron and G. B. Waterhouse: The Effects of Arsenic on Steel.—E. D. Campbell and H. W. Mohr: Specific Resistance and Thermoelectro-motive Potential of some Steels differing in Carbon Content.—R. H. Greaves and J. A. Jones: The Ratio of the Tensile Strength of Steel to the Brinell Hardness Number.—H. O'Neill: Deformation Lines in Large and Small Crystals of Ferrite.—A. Osawa: The Relation between Space-Lattice Constant and Density of Iron-Nickel Alloys.—T E. Rooney and L M. Clark: The Estimation of Phosphorus in Steels containing Tungsten.

Royal Society of Arts (Indian Section), at 4.30.—H Baker: The New Delhi.

Royal Astronomical Society (Geophysical Discussion), at 5.—Chairman: Dr. J. H. Jeans.—Dr. H E. Hurst: The Hydrology of the Nile.—H. Harries: The Relation between Barometric Pressure and Gas Pressure in Mines.—Dr H. Jeffreys: The Reflexion and Refraction of Elastic Waves. The Amplitudes of Bodily Seismic Waves.—R. Stoneley: The Effect of the Ocean on Rayleigh Waves.

Royal Society of Medicine (Laryngology Section), at 5.—Annual General Meeting.

British Institute of Philosophical Studies (at Royal Anthropological Institute), at 5.30.—Prof. E. F. Carritt: Contemporary Data for Æsthetics (Lecture)

Institution of Mechanical Engineers, at 6.—Fourth Report of the Marine Oil-Engine Trials Committee.

Society of Chemical Industry (Chemical Engineering Group) (at Florence Restaurant, 56 Rupert Street, W.C.1), at 6.30.—Annual General Meeting.

Society of Chemical Industry (Manchester Section) (at St. Mary's Parsonage, Manchester), at 7.—Prof. J. C. Drummond: Chemical Aspects of Organic Evolution.

Royal Society of Medicine (Anæsthetics Section), at 7.—Annual General Meeting.

Photomicrographic Society (at 4 Fetter Lane), at 7.—Annual General Meeting and Members' Evening.

Junior Institution of Engineers, at 7.30.—A. V. Ballhatchet: Distortion in Wireless Reception.

Geologists' Association (at University College), at 7.30.—Dr. D. R. Grantham: The Petrology of the Shap Granite.—G. W. Young: Notes on the Shoshone Valley, Yellowstone National Park, U.S.A. (Lecture).

Philological Society (at University College) (Anniversary Meeting), at 8.—Presidential Address.—Prof. D Jones: The Cardinal Vowels.

Royal Institution of Great Britain, at 9.—Sir Frederic G. Kenyon English Illuminated Manuscripts.

SATURDAY, May 8.

Royal Society of Medicine (Otology Section), at 10.30 a.m.—Annua General Meeting

Royal Institution of Great Britain, at 3.—Dr. P. C. Buck: Th Song Form in England as represented by Parry.

Royal Society of Medicine (Balneology and Climatology Section) (a Llandrindod Wells).

SUNDAY, May 9

Royal Society of Medicine (Balneology and Climatology Section) (a Llandrindod Wells).

PUBLIC LECTURES.

MONDAY, May 3.

University College, at 5.—Prof. G. Dawes Hicks: Hegel's Aesthetics

Imperial College of Science and Technology (Royal School o Mines), at 5.15.—Sir T. W. Edgeworth David: Past Ice Ages of th World, and their Control of Animal and Plant Life, with Special Refe ence to the Australian Evidence. (Succeeding Lectures on May 10 an 17.)

King's College, at 5.30.—Prof F. Delattre: La Personnalité d'Hen Bergson et l'Angleterre.

TUESDAY, May 4.

Imperial College of Science and Technology, at 5.—Dr P. Chalmers Mitchell: Logic and Law in Biology (Huxley Memorial Lecture)

University, Birmingham, at 5.30.—Sir Oliver Lodge: Difficulties abo the Ether (Huxley Lecture).

University College, at 5.30.—Prof. G. E. Moore: Universals an Particulars. (Succeeding Lectures on May 11 and 18.)

Gresham College (Basinghall Street, E.C.), at 6.—Sir Robert Arm strong-Jones: Physic. (Succeeding Lectures on May 5, 6, and 7.)

WEDNESDAY, May 5.

Lesser Free Trade Hall, Manchester, at 7.30.—Public Meeting connexion with the Manchester District Branch of the Electric Association for Women. Chairman: Principal B. Mouat Jone Speakers: Miss Ellen Wilkinson, Mr. J. A. Roberts, and Miss Haslett.

THURSDAY, May 6.

Imperial College of Science, at 5.30.—Brig.-Gen. H. B. Hartle Chemical Warfare.

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National Eugenics.

THE first parts of the new journal of the Francis Galton Laboratory for National Eugenics[1] should remove many misconceptions concerning both the methods and utility of later developments of the science which Galton founded. The editors contribute a short foreword reviewing the reasons which have prompted them in launching another large vessel of scientific journalism. Their tone may be considered in some quarters unduly combative; but it would be difficult to point to any accusation of prejudice or ignorance, explicit or implied, not strictly justifiable. When they state that "our journal will differ from existing journals in that . . . the papers published will be the work of trained scientists rather than of propagandists and dilettanti," the scarcity of journals devoted wholly to the scientific treatment of racial problems must be borne in mind. There appears to be no need to scent a slander upon all methods but those mathematical. Heredity may be viewed from other not less 'scientific' points of view than those of statistics.

Naturally, "a journal issued by the Galton Laboratory will be sympathetic to the methods of its founder, summed up in the title of his Herbert Spencer Lecture, 'Probability the Foundation of Eugenics.'" But the harvest of other disciplines is not excluded. Every new science is an "unclean novelty," and as a field for prejudices "the study of agencies under social control that may improve or impair the racial qualities of future generations, physically or mentally"—the subject of the Galton Laboratory—has been and is singularly fruitful. If impatience with prejudice is intelligible, so is impatience with the vague and dubious expressions of much descriptive biology. Yet no one knows better than the workers of the Galton Laboratory the importance of qualitative characters and the difficulties imposed by the absence of definitions where exact measurement is impossible.

Ultimately it is to descriptive biology that the biological statistician must go for scientific data. In practice the biometrician, if he has at times found fault with what he has received, has never disdained to seek light, in sociology or in medicine, upon his problems. The biologist, secure in a formulated if not a stereotyped discipline, has found no need for statistical aid, and thus has received less pressure to inform himself of even the most elementary details of his colleague's procedure. "Obsolete lumber" or not, the biological statistician is a fairly energetic raider of the storehouses of qualitative description. What is the truth underlying the editors' assertion that "eugenics requires now, and will require still more as it advances in the future, the most highly trained scientific minds," if it is not a plain admission that their science is a discipline as well as a technique, and that the only facts they can afford to condemn or opinions to despise are those that are false?

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[1] "Annals of Eugenics," vol. 1, parts 1 and 2. Edited by Karl Pearson, assisted by Ethel M. Elderton, 1925. (The University Press, Cambridge.) Annual subscription, 50s. net.

The present issue contains a pedigree of Epicanthus and Ptosis by C. H. Usher, a note on the correlation between birth- and death-rates, with reference to Malthus's interpretation of their movements, by Anthony B. Hill, and the first parts of two larger studies—one on the "Problem of Alien Immigration into Great Britain," by Karl Pearson and Margaret Moul, and the other on the "Relative Value of the Factors which Influence Infant Welfare," by Ethel M. Elderton, based on data provided by the Medical Officers of Health for Rochdale, Bradford, Blackburn, Preston, and Salford. Than this last it would be difficult to imagine a better illustration of the scope, methods, and difficulties of the technique adopted. The subject is essentially statistical but is complicated by all manner of circumstances from which an inquiry like that of the senior editor and his collaborator is free. For example, among the factors influencing viability, are considered the health of the parents, the habits of the parents, the condition of the home, the occupation of the father, the place in family of the child, the age of the mother at birth of the child, and the employment of the mother.

Surely it is of importance that questions of such social value should be studied and judged by methods more refined than those of casual acquaintance. It is impossible to read Miss Elderton's judicial reviews of her own results—which need not be summarised here as they are incomplete—without attaching to them a higher value than the partial results of other methods can claim. The same applies to the paper on alien immigration, the authors of which conclude that restriction is both nationally eugenic and practicable. With regard to both, some sentences in the latter paper may be quoted:

> "For the practical purposes of prognosis there does not exist in the present material any correlation of the slightest consequence between the intelligence of the child and its physique, its health, its parents' care or the economic and sanitary conditions of its home. No doubt the indiscriminative critic will assert that we advocate poor physique, carelessness in the parent, uncleanliness in the child with overcrowding and poverty in the home. The workers in the Galton Laboratory are fairly inured to that type of criticism. They hold, however, that the decencies of life are worth fighting for and obtaining for their own sake, and without an adventitious stimulus from vague assertions that their absence is the chief source of stupidity, if not indeed of mental defect, in the child. Philanthropists, seeking to reform deleterious conditions, never gain in the long run, when they proclaim, without due research, that these conditions are the unquestionable cause of all concomitant evils."

There was never such pressing need as to-day for the work of such a laboratory as the Galton Laboratory; only by the skilled and methodical sifting of facts can be reached a state of knowledge that will lead to a raising of the standard of national fitness.

The Study of History.

Geschichte der Mathematik und Naturwissenschaften im Altertum. Von Prof. J. L. Heiberg. (*Handbuch der Altertumswissenschaft.* Fünfter Band, Erste Abteilung, Zweite Hälfte.) Pp. v+121. (München: C. H. Beck'sche Verlagsbuchhandlung, 1925.) 7·50 gold marks.

THE fact is so well known that it is neither flattery nor even compliment to say that Prof. Heiberg is one of the most learned of living men. Theodore Gaza, I feel sure, knew no more Greek than he, nor can Casaubon or Selden or Bentley have been more industrious and more erudite. The booklet now before us is one of the least of Heiberg's works, but it is an astonishing performance; for he has managed to fit a real history of ancient science into its 120 pages. A reasonable share, some fifty pages, goes to the great subject of mathematics; a delightful sketch of ancient medicine occupies the last thirty pages of the book; and between the two are readable and most instructive chapters on astronomy, mechanics, optics, music, and natural science.

When Zeuthen, another very learned Dane, wrote his short "History of Mathematics," he was more concerned with the development of mathematical concepts than with the precise part in that historical evolution which A or B happened to play; his little book was not over-full, but it was the perfection of lucidity. Prof. Heiberg's book is of a different kind, for it is an encyclopædic article which he has undertaken to write. It is packed to overflowing with information, but it is still exquisitely clear; it seems to touch on everything, and to omit nothing. Short as it is, every student of the history of science will want to keep it by his side.

To epitomise the long chapter on mathematics is beyond our powers; let us glance at the shorter chapter on ancient astronomy. Anaximander comes first, disturbing the old Homeric cosmogony; the Pythagoreans, Philolaus, Anaximenes, and the rest, down to Oinopides and Anaxagoras, are next passed in review. Plato is shown to have given a firm foothold to astronomy in Athens, and we are told how the fantastic or at least poetic cosmology of the "Timaeus" and the

"Phaedo" led on to the more prosaic but more scientific work of Eudoxus and Callippus. There follows the great figure of Aristarchus (for whom we are, of course, referred to Sir Thomas Heath), and with Aristarchus we seem to have well-nigh reached to the Copernican system; Heiberg does not forget to tell us, from Plutarch, how Cleanthes abandoned Aristarchus's views as impious, and how Seleucus alone clave to him—that Seleucus who, together with Heracleides, would seem to have been the first to conceive of our universe as ἄπειρος, or infinite.

The rival theories of epicycles and of circular but eccentric orbits are next discussed, and the particular relation of the former to the cases of Mercury and Venus is shown to foreshadow the views of Tycho Brahe. Meton and Euctemon, the great Athenian calendar-makers, come next in order; and then we pass quickly to the story of the constellations, and to the popular poem of Aratus, with its many translators and commentators—that very poem which St. Paul quoted in his sermon on Mars' Hill. Hipparchus, Theon, and Ptolemy are all discussed quietly and even leisurely. Next come Proclus and the other Neo-Platonists; then the few Roman scholars, such as Varro, Seneca, Martianus Capella, Manutius and Manilius, the last of whom plays his part, with Manetho, Firmicus, and Hephaestion, in the long history of astrology. Even the Byzantines, such as that great scholar of the eleventh century, Michael Psellus, or Leon the Philosopher, or Manuel Comnenus the Emperor, are not forgotten; and who knows the Byzantines better than Prof. Heiberg? The footnotes and references to books and scattered pamphlets are very copious; and out of his vast knowledge of MSS. Heiberg points out every here and there how this or that remains to be studied: how a commentary of Michael Psellus on Ptolemy lies uncollated in Paris, how a MS. of Theodore Metochiton awaits an editor in the Marcian, or how there is still much more of Vettius Valens than Cumont or Boll have told us of.

Prof. Heiberg handles the immense literature of ancient mathematics, medicine, and the natural sciences with the selfsame ease. His story runs so smoothly it never reads like a compilation: we feel all the while that the writer is giving us only what he has made his own, that he has endless material in reserve, and that he can afford us little allusions and sidelights in plenty, which are far beyond the mere compiler's reach and ken. It is not everybody who happens to know that Jo. Philoponus and Simplicius, the Aristotelian commentators, were at daggers drawn; or that Barlaam of Calabria (who paraphrased the 2nd Book of Euclid) was the schoolmaster both of Petrarch and of Boccaccio.

D. W. T.

Photosynthesis.

Photosynthesis: the Assimilation of Carbon by Green Plants. By Prof. Walter Stiles. Pp. vii+268. (London: Longmans, Green and Co., 1925.) 16*s. net.*

A WRITER of some considerable eminence says, in prefacing his account of one of our English shires, "In the account which follows my aim has been to gather a . . . bouquet rather than to present the facts which the more practical traveller requires." Prof. Stiles is less definite in his preface to the highways and byways of photosynthesis. In his preface we find "an attempt is made to present a view of our present knowledge . . . it is intended to be more general in its scope" than an earlier account by Prof. Stiles and Mr. Jorgensen, which "was essentially a critical account of what were then recent developments of the subject." Further on we find that the present account "is not simply a critical review of recent developments." We are left in doubt as to whether our fate is facts, bouquet, or both.

We find that our guide has not stinted us of facts on the structure of assimilatory organs, the composition of the protoplasm of non-assimilatory organisms, the chemical composition of the green and yellow pigments of the leaf and how to separate them, the methods of measuring assimilation, the variation of the rate of the process with change of external and internal factors, and so on. In fact, we might almost say that the author's hope "that no important work has been overlooked" has been realised.

Bouquets are, however, subtler and personal things in more ways than one. Selection and perhaps arrangement are required. If we have all the facts it is perhaps hopeless to expect selection, but one does look for some indication of the reaction of the collector to the facts he brings together for us. Prof. Stiles usually refrains from revealing himself, and when he does make comments he is sometimes misleading. In his account of methods of measuring photosynthesis he commits himself to saying that the continuous current method is the most reliable of all methods that have been evolved for measuring photosynthesis. Apart from the facts that 'continuous current' describes the supply and removal of substances rather than their measurement, and that the reliability of the measurement is not affected by the method of supply, the subject has many aspects. What is the explanation of the low values obtained by Brown and Escombe when using this method? That these values are low is shown by the rate at which the plant increases in dry weight under natural conditions. Prof. Stiles puts forward as an objection to the eudiometric method the fact that the transpiration of a leaf into a closed space disturbs the water relations of the leaf. We imagine that disturbed water relations is the explanation of the discrepancy between the results of Brown and Escombe and those obtained by other methods. The real point is that with different technique we have different sets of conditions both external to and inside the assimilating organ, and it is not reliability of method but the type of problem tackled which usually decides the technique. The quotation of the expression

$$x_{O_2} = \left[v_G \cdot \frac{273}{T} + v_F a_{O_2} \right] \frac{P-p}{76,000} \left(\frac{b_{N_2}}{b'_{N_2}} \cdot b'_{O_2} - b_{O_2} \right),$$

used by Warburg in calculating assimilation, makes one wonder for what class of reader the book is intended.

The author is not much happier in expressing himself when he is commenting upon the experimental results recorded. In the section on the relation between rate of assimilation and the concentration of carbon dioxide, we find "Warburg selected the unicellular alga *Chlorella* because in such a minute object the concentration of carbon dioxide at the surface of the chloroplast must be in approximate equilibrium with that in the water outside so that complications introduced by the diffusion stage are practically eliminated." What the complications are is not stated, but presuming that equilibrium means equality, we think that the author might have explained how size of object came in, and referred to the importance of the medium, water or air, and the relative amounts of carbon dioxide and bicarbonate. Later we find that in the experiments of Blackman and Smith it "does not appear likely that the rate of photosynthesis might have been determined by the diffusion." Whatever the author may mean, this statement is misleading, for no matter what the nature of the organism the rate of photosynthesis *is* the rate of supply of carbon dioxide to the seat of the reaction.

It is remarks such as the above that make one feel that our author, to return to our earlier analogy, is but a hurried visitor to our shire, and that but few of our intricate scenes have bewitched him so much that he has lingered awhile, and perhaps none has returned to him in his sleep. With so much ground to cover, it would perhaps be unreasonable to expect much of a visitor

We have discovered but one error. The experiments of Willstatter and Stoll with elm leaves were carried out with a light intensity which these workers call 24,000 lux, and not 48,000, as stated on p. 181 We should also like to protest against the continued confusion of Blackman's Law of Limiting Factors and the laws of Liebig and Malthus. The first refers to rates of a process, whilst the last two refer to size of a community of organisms.

It would indeed be surprising if the first book of its type were perfectly satisfactory. Plant physiologists and others are indebted, however, to Prof. Stiles for courageously pushing on where others have hesitated. The presence of more than eight hundred and seventy references in the bibliography may give some idea of the labour involved.

G. E. B.

The Integration of Physiology.

Principles of Human Physiology. By Prof. Ernest H. Starling. The Chapter on the Sense Organs edited by Dr. H. Hartridge. Fourth edition. Pp. xiii + 1074. (London: J. and A. Churchill, 1926.) 25*s.* net.

IT is not too much to say that the "Principles of Human Physiology" forms a definite landmark in English text-books on this subject. It is not many decades since a comprehensive text-book on physiology could have been written by almost any professor of the subject. To-day, owing to the rapid growth and differentiation of the subject, for which the large amount of research work and the still larger volume of published matter are responsible, there are few of our experts who would care to attempt the task, and of these a still smaller number would have any chance of success, so difficult is it to keep in touch with the advance of a subject which avails itself of the contemporary advances in so many other branches of science.

There have been attempts, especially on the continent, to overcome this difficulty by the collaboration of several authors in the preparation of a text-book, and while it must be admitted that such a book may gain in precision, as it does in detail, yet these advantages must be in great measure offset by the lack of homogeneity from which such an effort must inevitably suffer. One even finds, in such productions, that the authors of different sections often express opinions diametrically opposed to one another. Out of a hundred readers of such a book, ninety-nine find themselves unable to form any definite opinions, while to the hundredth, himself an expert, the book is superfluous.

It is therefore a matter of the most urgent necessity to a subject like physiology that it be kept from falling to fragments, by being written up in an integrated fashion by a master hand. A book such as this serves, therefore, not only for the instruction of students, but also for the orienting of physiologists themselves in branches of their subject which they have not, by their research work, made peculiarly their own.

Aware of the magnitude of the task which the author has undertaken, we must therefore be prepared to overlook small errors of omission or commission or partiality, which are inseparable from such works, and in doing so we gain much more than we lose, for we do not think that a better balanced text-book of physiology has ever been or could possibly be written. Although much new matter has been added, the bulk of the volume has been reduced by the deletion of a good deal of the organic chemistry which occupied space in former editions. Some of the chapters might with advantage have been extended a little in order to preserve the same treatment of detail throughout; thus, the chapters on the endocrine organs might well occupy twice their present space; as it stands at present, the physiology of the pituitary body, for example, occupies less space than, say, the general biology of nitrifying bacteria. But these are small cavillings, and we must feel grateful to the author for the splendid viewpoint of physiology which he has given us.

The chapter on the sense organs has been edited by Dr. H. Hartridge, and is excellently done; it is certainly an advantage to have this specialised chapter revised by one who has devoted particular attention to the subject, and the inclusion of this chapter in no way mars the continuity of the book. Many of Prof. Starling's colleagues have assisted him in the preparation of chapters dealing with subjects which they have made heir own, and when we see how much of the matter ncorporated in the book has emanated from the aboratories of University College, London, we feel how ruly great has been the influence which Prof. Starling nd his colleagues have exercised on the recent evelopment of the science of physiology in Great Britain.

"Principles of Human Physiology" appeals most to those students who wish to get acquainted with the cientific side of physiology as it is to-day. The edical student who wishes to build a proper foundation or his clinical studies will be wise to choose it, and the cience student working for a degree in physiology nows it to be indispensable; for physiologists themelves it is too well known to need further commendation.

An Australian Encyclopædia.

he Illustrated Australian Encyclopædia. Edited by Arthur Wilberforce Jose and Herbert James Carter. Vol. 1: A to Lys. Pp. x + 768 + 26 plates. (Sydney, N.S.W.: Angus and Robertson, Ltd.; London: The Australian Book Co., 1925.) n.p.

THE first volume of an illustrated Australian encyclopædia, by Captain A. W. Jose, a well-nown Australian journalist and historian, and Mr. . G. Carter, president of the Linnean Society of New outh Wales, forms an important addition to the reference books on Australia. The work was begun as an historical and biographical dictionary in 1912, but after the War it was resumed and enlarged by the inclusion of Australian science. The volume is illustrated by numerous text figures and a series of beautiful plates, of which ten are coloured, and show characteristic algæ, insects, birds, eggs, and reptiles.

Amongst the scientific articles in this first volume are those on the aborigines, in which Mr. S. H. Ray deals with the languages, Sir Baldwin Spencer with the customs and tribal organisation, and Dr. Ramsay Smith with the origin and physical character. Dr. Smith repudiates as baseless the view that the aborigines are mentally so primitive that they are unable to count up to more than four, as some uncivilised tribes have numerical names for children up to ten; they are very quick in mental arithmetic; and he says that the "ordinary black fellow is as good at figures as his white brother," that the aboriginal children at schools can be educated like white children and to the same extent, and that the "parents object to any distinction in the curriculum or the standard." Dr. Ramsay Smith says that it is now established that the Australians are a homogeneous race of Caucasian stock. Mr. Ray, though rejecting some of the claims for the affinities of the Australian and South Indian languages, remarks that the Dravidian and southern Australian are of the same morphological type.

The article on artesian water refers to the widespread decline in yield of the Australian wells, and the view that their discharge is due to gas pressure caused by the inflow of superheated plutonic water is noticed in terms which show that the theory is regarded more seriously in Australia than when it was put forward twenty years ago.

The article on flight traces the foundation of the modern aeroplane to the work of Hargraves, and quotes the prediction by Sir Richard Threlfall, in rebuke of its local neglect, that the time would come when Sydney would be less famous for its harbour than as "the home of Lawrence Hargraves, the inventor of human flight." Two of the more important articles are those on economic geography by Prof. Griffith Taylor, and on geology by Sir Edgeworth David and Prof. Cotton. In the latter article the glacial beds of Adelaide are said to be probably Proterozoic, but possibly Cambrian, and the term Permo-Carboniferous is retained mainly as a matter of custom, with full recognition that the beds in question are Permian. The article on irrigation describes many adventurous enterprises; that on the ballot recalls its first adoption in Australia and its original name of the Australian Ballot; and that on the Labour Movement is sympathetic, but does not bring the story later than 1915.

T I

Birds of Eastern China.

A Handbook of the Birds of Eastern China (Chihli, Shantung, Kiangsu, Anhwei, Kiangsi, Chekiang, Fohkien and Kwantung Provinces). By J. D. D. La Touche. Part 1 (containing Families Corvidæ, Paridæ, Panuridæ, Sittidæ, Certhiidæ, Troglodytidæ, Paradoxornithidæ, Timaliidæ and Pycronotidæ. Part 2 (containing Families Cinclidæ, Turdidæ, Muscicapidæ and Laniidæ). Pp. 97-192+plates 4-7. (London: Taylor and Francis, 1925.) 7*s.* 6*d.* net.

TWO parts of Mr. La Touche's work on the birds of Eastern China have now appeared, and if the standard set in these two parts is maintained, a long-felt want in ornithological circles will be admirably filled. Since the appearance of Oustalet's "Oiseaux de la Chine" in 1877, no book of any importance has been written on any of the larger areas of China, although a considerable amount of work has been done, and many authors, Ricketts, Styan, La Touche himself, Jones and Vaughan and other naturalists, have from time to time published articles in the *Ibis* and other ornithological journals. The author of the present work has adopted Stuart Baker's classification as given in the "Avifauna of British India"; a classification which will make it easy for readers of oriental ornithology.

In a work of this kind there are naturally certain minor points upon which all ornithologists may not be able to agree with the author, but it is obvious that he has bestowed so much thought upon his work and has drawn his conclusions with such care and deliberation that his decisions will always have to be examined with attention before being discarded. We notice that Mr. La Touche divides *Parus major* and *Parus cinereus* into two species, although he himself admits that the two grade into one another. On the other hand, in the second portion of his work, he treats *Turdus ruficollis* and *Turdus atrogularis* as races of one species, and quotes Stresemann to the effect that these two so-called subspecies hybridise.

The majority of Mr. La Touche's new forms have already been described in the *Bulletin of the British Ornithologists' Union*. In Part 1 we have *Pyctorhis sinensis major* and *Pycnotus sinensis stresemanni*, whilst in Part 2 we have *Cynclus pallasii wilderi* and *Hemichelidon sibirica incerta*, but we would note that the types of these sub-species has not been recorded.

When we come to the field notes, we find these to be very full and most interesting, due no doubt to Mr. La Touche's long and intimate knowledge of the countries harbouring the birds he discusses. So far, no map has been given of the localities treated, but we understand that one is to be given in Part 3 of this work, and such a map will add greatly to its value.

We may congratulate Mr. La Touche on having produced a work which is not only sound from a scientific point of view but is also one of great interest. No student of oriental ornithology but will welcome its appearance, and the chance of obtaining, at so moderate a price, so excellent a work.

Our Bookshelf.

Sampling and Testing of Highway Materials. By Prof. Wm. H. Barton, Jr., and Prof. Louis H. Doane. Pp. ix+355. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 17*s.* 6*d.* net.

THE scope of this book is more extensive than its title would indicate, seeing that it includes a general treatment of cements, bricks, and aggregates, together with a variety of miscellaneous materials. The joint work of two American engineering professors, the treatment follows the usual lines of American laboratory manuals, the organisation of the testing-room being described with minutest detail and the various experiments outlined in routine form. The consequent 'cookery book' diction is necessarily pronounced; but, after all, the method pursued is possibly the best for those who are to perform the tests; while others, with laboratory experience in directing students, will appreciate the emphasis laid upon care and caution in conducting quasi-scientific tests in accordance with pseudo-empirical rules. In cement testing alone, this book will prove invaluable in the laboratories of the various colleges and departments, since it prescribes a number of tests additional to those usually recognised.

Of its nine chapters, the first three are devoted respectively to laboratory practice, sampling, and Portland cement and concrete. Even the specialist might benefit by perusal of these. Comparatively little has yet been attempted in Great Britain in regard to the standardisation of tests for hardness abrasion resistance, toughness, etc., of stones. Chap. v. appears to lack scope and system in dealing with miscellaneous materials, but these deficiencies are compensated for to a great extent by the treatment of bituminous materials in the succeeding chapter.

The thirty-six pages of Chap. vii. are devoted to specifications, mainly in accordance with the requirements of the American Society for Testing Materials The collection of diagrams and tables in Chap. viii affords a useful appendix to the book. Nine diagrams showing the effects of various factors on the strength o concrete, are included, while, additional to a number in the text, twenty-five useful tables are given of a typ rarely found in text-books. A concluding chapter "Subgrade Soils," is by Mr. J. R. Boyd, Assistant Engineer of Tests, U.S. Bureau of Public Roads Washington.

The History of Protozoology: Two Lectures delivere before the University of London at King's Colleg in May 1925. By Prof. F. J. Cole. Pp. 64+2 plates (London: University of London Press, Ltd., 1926.)

THIS little volume is based on two lectures delivere by Prof. Cole at King's College, London, in 1925. It is impossible in the small amount of space at the author's disposal to give more than a brief outline of the more important events in the history of protozoology; but it must not be assumed on this account that this has become a mere recital of dates and names. Far from it. By means of a judicious selection of the more important events in protozoological discovery and by the neglect of all matter of a controversial nature, Prof. Cole has prepared a very readable book which gives a much-needed sense of perspective to a branch of science which has been so very rapid in its growth. He emphasises the difficulties under which the pioneers worked and shows that we cannot appreciate them at their true value unless we rid ourselves of our modern bias. He illustrates "not only the importance of success, but the significance of failure. In criticising our predecessors, we must not forget that we stand on their shoulders and that we owe as much to their errors as to their wisdom."

Commencing with Leeuwenhoek, the "Father of Protozoology," the more important discoveries are indicated and their importance shown. The greater amount of space is given to the work of the past century—an era when so many brilliant discoveries in the medical and economic fields were made. The whole of the science is covered, however, not merely the economic sides, and an extensive bibliography is appended by means of which the student is encouraged to pursue further the subject to which this forms such an interesting introduction.

Air Ministry: Meteorological Office. The Meteorological Observer's Handbook. Approved for the Use of Observers by the Meteorological Office and the Royal Meteorological Society. 1926 edition. (M.O. 191.) Pp. viii + 136 + 36 plates. (London: H.M. Stationery Office, 1926.) 5*s.* net.

This work is of interest to all meteorologists without distinction of the branch of weather study in which they are concerned, and its essentials are as necessary to trained physicists as to the more ordinary observer whose work is somewhat empirical. The necessity for uniformity of practice has been kept well in view, and with regard to temperature and rainfall, details as to position and exposure are of primary importance. The decisions of international conferences are adhered to so far as practicable.

Instructions are given for making observations of the several elements, except that observations of the free atmosphere are not dealt with, this information being contained in other publications. There are copious illustrations of autographic instruments, and details are given for their management. There are also complete tables for the manipulation and correction of the various observations. With many elements where diurnal variation is concerned, summer time has to be disregarded so far as is practicable by the observer or most important defects would be the result of observation. Notes of important action should be carefully entered in the permanent register.

A new section on visibility, of special importance for navigation on the sea or in the air, has been introduced, and by its aid good observations can be made either by day or night. A number of cloud pictures are given, and the excellent representations will enable an observer to identify the various cloud forms. A study of the work cannot fail to interest an observer.

(1) *A First Course in Statistical Method.* By Prof. G. Irving Gavett. Pp. vii + 358. (New York: McGraw Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 17*s.* 6*d.* net.

(2) *Mathematics of Life Insurance.* By Prof. L. Wayland Dowling. (Modern Mathematical Texts.) Pp. x + 121. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 8*s.* 9*d.* net.

Hand in hand with the boom in industry in the United States there has been a continued spate of text-books on statistics, life insurance, and the mathematics of finance generally. The mathematical knowledge required to master these books, generally speaking, does not extend beyond elementary algebra, mainly permutations and combinations, and sometimes, but not always, a knowledge of differentiation. In the first of the above works, for example, there is a special appendix on "Derivatives and Integrals" expounding a great deal less than is known by the average schoolboy just entering a university course in Great Britain. Yet the scope of the work includes frequency, dispersion, skewness, probable error, curve-fitting, correlation and regression. It means, of course, that no time is wasted in arguing with the reader; he is just told. If he is not satisfied with this, he will find in these works numerous illustrations in which it *is* so.

The second of these books should be of value to those desiring to master the methods of calculation adopted in the many forms of insurance. It is really a book on arithmetic and algebra applied in a stimulating manner to an interesting series of special problems, and is very readable. Both works are well produced.

The Journal of the Institute of Metals. Volume 34. Edited by G. Shaw Scott. Pp. 799 + xi + 33 plates. (London: Institute of Metals, 1925.) 31*s.* 6*d.* net.

Metallographic studies of alloys of the non-ferrous metals occupy a large part of the present volume, and it is satisfactory to observe that in this field of research England takes the leading place. Such an investigation as that of Drs. Hanson and Gayler on the ternary alloys of aluminium, copper and zinc, with its extraordinarily complex equilibria, shows to what perfection the methods of study in this field have been brought. Two quite independent investigations deal with the β-brasses and their transformation at 470°, both arriving at the conclusion that a eutectoid is not formed, and that the transformation is one which is not accompanied by any change of structure. The copper-tin and copper-cadmium alloys are also studied. Two papers are concerned with the influence of time in tensile tests conducted at high temperatures, this being now a matter of technical importance, on account of the need for metals which can withstand continuous loading at high temperatures. A note on the copper objects of the American Indians before the arrival of the Spaniards will be of interest to archæologists. The objects are of pure material, apparently Lake Superior native copper. More than half of the volume is occupied by abstracts, the literature relating to non-ferrous metals having now been brought up-to-date, and covering a very wide field. This work is remarkably well done, and is worth consulting by others than metallurgists, on account of the large quantity of data brought together from many sources.

Letters to the Editor.

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Spinning Electrons.

I UNDERSTAND that in the newly proposed spinning electron the periphery is supposed to move faster than light, and the question has arisen in some minds whether such a motion can be allowed by the relativity theory. I think an assurance can be given that the relativity theory raises no objection.

It must be remembered that the mass and energy of an electron are considered to reside in the electromagnetic field outside its boundary. Whether the electron spins or not, this field is steady, so that there is no question of any transport of mass or energy with speed faster than light. It is only when *energy* or *signals* are alleged to go faster than light that the relativity theory is moved to intervene. Further, the spinning electron represents a state of the world-distribution of charge-and-current vector—which, while differing from that of an electron at rest, is nevertheless equally static and unchanging. It seems almost an abuse of language to apply the term velocity in connexion with a structure which is perfectly stationary; but the description in terms of spin may be held to serve its purpose since it leaves no doubt as to the structure intended.

The mathematical definition of velocity (dx/dt) contains no special reference to motion in a dynamical sense, x is merely the co-ordinate of a selected succession of world-points, and there is in the definition no guarantee that dx is traversed by anything except the thought of the mathematician. In describing the electron as spinning, what happens is that, faced with a hitherto unimagined structure, we make our thought skip faster than light round its boundary, and by so doing succeed in seeing a correlation with a more familiar structure, namely, that of an electron at rest. The correlating velocity has no more physical existence than has the factor $\sqrt{-1}$ used to correlate the structure of the four-dimensional world to the more familiar structure of a four-dimensional Euclidean space. In a deeper analysis we should not speak of a moving charge-element but of a charge-and-current vector, motion being attributable only to boundaries or analogous features of charge distribution—not to *charge*, but to *a charge*. When in the cruder description the charge moves faster than light, the charge-and-current vector J^μ becomes *space-like*. (In ordinary macroscopic phenomena J^μ is always *time-like*.)

It may be interesting to recall that the conclusion that the electron contains a space-like J^μ was already reached tentatively from a study of the interrelation of the electromagnetic and gravitational fields (see my "Mathematical Theory of Relativity," p 211). It is deduced from Weyl's action-principle. So far as I can make out, Weyl himself reached a different conclusion, but it seems a straightforward result from his theory. From the action-principle a formula was obtained connecting mass-density with the electric vector ($\rho_0 = -(\beta^2/12\pi)J^\mu J^\mu$) and the conclusion was—"Since the density of matter is always positive, the electric charge-and-current inside an electron must be a *space-like* vector, the square of its length being negative. It would seem to follow that the electron cannot be built up of elementary electrostatic charges but resolves itself into something more akin to magnetic charges." A. S. EDDINGTON.

Observatory, Cambridge,
April 24.

I FEEL that there are serious arguments against the two objections raised by Mr. Kronig (NATURE, April 17, p. 550) to the view that the electrons in the atom possess an inherent magnetic moment, a view which Uhlenbeck and Goudsmit have shown to have important spectroscopic consequences. I will consider first the second objection, which seems to me to involve implicit assumptions about the structure of the atomic nucleus which go far beyond our present knowledge of the facts or even of the probabilities. I am prepared to follow Mr. Kronig to the extent of believing that if an electron has a quantised spin when in a Bohr orbit, an electron which has the privilege of taking part in the building up of an atomic nucleus will have the same property of possessing one or more units of angular momentum or of magnetic moment. But it seems to me improbable that the electron after it has entered into the composition of the nucleus will be able, as an individual electron, to retain this angular momentum. The 'dimensions' of the nucleus are not very much greater than those of an electron, and as the nucleus may contain a very considerable number of electrons and protons, it must be a highly interlocked structure of a kind which scarcely seems likely to afford opportunity for the ordered spinning contemplated.

I suggest that what is more likely to happen is that the electron gets rid of this angular momentum in the process of nucleus formation either by passing it on to the nucleus as a whole or else by radiating it away. If the angular momentum is transferred to the nucleus as a whole, its magnetic effect becomes negligible owing to the much higher moment of inertia of the rotator; so that in either event the nucleus would have no appreciable magnetic moment. That the nucleus as a whole does possess a quantised angular momentum is shown by the mechanical gyromagnetic anomaly, as I showed in 1922 (*Roy. Soc Proc.*, A, vol. 102, p. 538), and also, though less directly, by the corresponding and similar spectroscopic anomaly. In any event the magnitude of the mechanical gyromagnetic anomaly makes it necessary to admit the existence of a quantised spin of the nucleus, a structure the 'dimensions' of which are not much greater than those of an electron.

As regards the first objection, the statement as to the foundation of the Bohr magneton resting on the orbital motions of electrons which can be treated solely as point charges moving with velocities small compared with that of light, seems to be too narrow. If it is assumed that an electron is a sphere of radius R carrying a charge e and that the inertia is entirely electromagnetic (these are the simplest assumptions which can be made), the application of the quantum condition $\int pdq = nh$, where p is the angular momentum, requires that for any rotation the magnetic moment of a spinning electron should be $n \cdot eh/4\pi cm$ where n is an integer and the other factor is the magnitude of the 'Bohr magneton.' O. W RICHARDSON.

King's College,
Strand, W.C.2.
April 19

IN view of the letters recently published in NATURE upon the subject of rotating electrons, it may be o interest to mention some attempts made four years ago to use this idea in explaining the stability of the nucleus. It is common knowledge that the fact that nuclei can exist despite their excess positive charge cannot be explained without introducing hypotheses outside the classical electrodynamics. Whilst the electrostatic attractions which would lead to collapse of matter may be balanced by the centrifugal acceleration of the particles on stationary quantised orbits, no inertia effect can compensate the electrostatic repulsion which should lead to the explosion of the nucleus.

The idea, which was not pursued as it did not seem susceptible of quantitative examination, was to assume that protons and electrons are rotating at speeds given by the usual quantum condition. It is at once evident that one cannot go very much further without making some arbitrary assumption—

1. About the distribution of electricity and mass in the proton or electron, if indeed either term has any meaning when referred to part only of a particle.
2. About the force holding the proton or electron together if the parts repel one another as they would if the ordinary laws of electrodynamics apply to them
3. About the magnetic field of a rotating proton or electron.

This much, however, is clear, that if the effective radii are of the order usually assumed, the peripheral speed would in either case approach the velocity of light and that the peripheral speed of the proton would approach it somewhat more closely than that of the electron. If anything like the ordinary laws hold, this means that protons and electrons will have intense magnetic fields, almost, but not quite balancing their electrostatic fields at distances of the order of their radii, the magnetic field of the proton being somewhat greater than that of the electron. At greater distances, of course, the magnetic forces would disappear compared to the electrostatic forces, since their value decreases more rapidly than with the square of the distance.

With such particles it is clear that stable nuclei can be built up, for the magnetic forces can be arranged all to support cohesion, whilst, of course, only the excess positive charge is available to cause disruption. Since the positive particle with its greater mass has the greater peripheral speed and magnetic field, an excess positive charge can be accommodated. It is possible to make fairly plausible assumptions which explain the stability of the simpler nuclei, but as it is impossible to base them upon any exact calculation without making hypotheses about the internal forces, they are scarcely worth recording.

F. A. LINDEMANN.

Clarendon Laboratory,
Oxford, April 23.

IN a recent letter to NATURE (February 20, p. 264), Messrs. Uhlenbeck and Goudsmit have shown how the theory of the spinning quantised electron can be applied to the problem of the multiplet structure of spectral lines and that of the anomalous Zeeman effect. In both cases the theory gives excellent results, if the ratio m/M of the magnetic moment to the mechanical one is identified with the corresponding ratio for the orbital motion ($e/2cm_0$, where e is the charge and m_0 the mass of the electron) in the former case, and to the double of it in the latter.

The following is a brief account of a solution of this paradox on the basis of the special relativity theory (the fuller publication being reserved for the *Zeitschrift fur Physik*).[1]

Without entering into the consideration of the spinning motion of the electron and into speculations about its 'inner structure,' we shall treat it merely as a point, associated with a vector $\mathbf{m}$, corresponding to the magnetic moment, and possessing a mechanical moment $\mathbf{M}=\frac{1}{\kappa}\mathbf{m}$. From the point of view of the relativity theory, a three-dimensional vector quantity must be considered as the space part either of a four-dimensional vector with four components or of an antisymmetrical tensor with six components. Now, the magnetic intensity $\mathbf{H}$ represents, as is well known, the space part of the electromagnetic field antisymmetrical tensor $F_{\alpha\beta}=-F_{\beta\alpha}\ (\alpha,\beta=1,2,3,4)$ the 'time part' of which corresponds to the electric intensity $\mathbf{E}$, according to the Minkowski substitution.

$$\begin{pmatrix} F_{23}, & F_{31}, & F_{12}, & F_{14}, & F_{24}, & F_{34} \\ H_1, & H_2, & H_3, & -iE_1, & -iE_2, & -iE_3 \end{pmatrix}.$$

It appears necessary, therefore, to introduce as the four-dimensional extension of $\mathbf{m}$ an antisymmetrical 'moment tensor' $\mu_{\alpha\beta}=-\mu_{\beta\alpha}$:

$$\begin{pmatrix} \mu_{23}, & \mu_{31}, & \mu_{12}, & \mu_{14}, & \mu_{24}, & \mu_{34} \\ m_1, & m_2, & m_3, & ip_1, & ip_2, & ip_3 \end{pmatrix},$$

the 'time part' $\mathbf{p}$ of which is a three-dimensional vector analogous to the electrical moment of a dipole.

The corresponding extensions for the three-dimensional magnetic energy $-\mathbf{m}\,.\,\mathbf{H}$ and torque $\mathbf{m}\times\mathbf{H}$ with components $m_\alpha H_\beta - m_\beta H_\alpha$ are then easily seen to be $U=-\frac{1}{2}\mu_{\alpha\beta}H_{\alpha\beta}$ (the summation sign for equal index-pairs being omitted), and $f_{\alpha\beta}=m_{\alpha\gamma}F_{\beta\gamma}-m_{\beta\gamma}F_{\alpha\gamma}$ Denoting the electron's 'proper time' with τ, we then get the following equations for the 'spinning motion,' that is, the rate of change of $M_{\alpha\beta}$:

$$\frac{1}{\kappa}\frac{d\mu_{\alpha\beta}}{d\tau}=\mu_{\alpha\gamma}F_{\beta\gamma}-\mu_{\beta\gamma}F_{\alpha\gamma}, \quad . \quad . \quad . \quad (1)$$

which are equivalent to

$$\frac{1}{\kappa}\frac{d\mathbf{m}}{d\tau}=\mathbf{m}\times\mathbf{H}+\mathbf{p}\times\mathbf{E},\ \frac{1}{\kappa}\frac{d\mathbf{p}}{d\tau}=\mathbf{p}\times\mathbf{H}-\mathbf{m}\times\mathbf{E}. \quad (2)$$

These equations are, however, strictly valid in that case only, when no *a priori* relation between $\mathbf{m}$ and $\mathbf{p}$ exists. In the case under consideration these vectors are connected with each other by the invariant relation

$$\mu_{\alpha\beta}\dot{x}_\beta=0\ \left(\dot{x}_\beta=\frac{dx_\beta}{d\tau}\right), \quad . \quad . \quad . \quad (3)$$

that is

$$\mathbf{p}=\frac{1}{c}\mathbf{v}\times\mathbf{m}, \quad . \quad . \quad . \quad . \quad (4)$$

expressing the fact—or rather the *assumption*—that in a co-ordinate system, in which the electron's translational velocity $\mathbf{v}$ is zero, the 'electrical moment' $\mathbf{p}$ must vanish. In order to account for this restriction one must replace the energy function U by $U'=-\frac{1}{2}\mu_{\alpha\beta}F_{\alpha\beta}-A_\alpha\mu_{\alpha\beta}\dot{x}_\beta$, where A_α are the components of an indefinite vector multiplier, and accordingly replace the equation (1) by

$$\frac{1}{\kappa}\frac{d\mu_{\alpha\beta}}{d\tau}=\mu_{\alpha\gamma}F_{\beta\gamma}-\mu_{\beta\gamma}F_{\alpha\gamma}+A_\gamma(\dot{x}_\alpha\mu_{\beta\gamma}-\dot{x}_\beta\mu_{\alpha\gamma}). \quad . \quad . \quad (5)$$

By means of the relation (3) and $\dot{x}_\alpha\dot{x}_\alpha=-c^2$ the following expression is found for A_γ:

$$A_\gamma=\frac{1}{\kappa c^2}(\kappa F_{\gamma\beta}\dot{x}_\beta-\ddot{x}_\gamma). \quad . \quad . \quad . \quad (6)$$

A more rigorous deduction of these equations, as well as of the corresponding equation for the translatory motion of the spinning electron, is achieved by means of the Hamiltonian principle $\delta\int L d\tau=0$, with the two accessory conditions $\dot{x}_\alpha^2 = -c^2$ and $\mu_{\alpha\beta}\dot{x}_\beta = 0$, the Lagrangian function having the form $L = \frac{1}{c}\phi_\alpha\dot{x}_\alpha + T + \frac{1}{2}\mu_{\alpha\beta}F_{\alpha\beta}$, where ϕ_α is the electromagnetic potential and T the 'kinetic energy' of the electron's spin. This quantity as well as $\mu_{\alpha\beta}$ must be regarded as functions of the 'angular velocity' $\omega_{\alpha\beta} = -\omega_{\beta\alpha}$, their variations being expressed by $\delta T = \frac{1}{2\kappa}\mu_{\alpha\beta}\delta\omega_{\alpha\beta}$ and $\delta\mu_{\alpha\beta} = \mu_{\alpha\gamma}\delta\Omega_{\gamma\beta} - \mu_{\beta\gamma}\delta\Omega_{\gamma\alpha}$ $(d\Omega_{\alpha\beta} = \omega_{\alpha\beta}dt)$.

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[1] This question has been already treated on different lines by Dr. Thomas, of Copenhagen I am indebted to Dr W. Pauli for the possibility of taking notice of Dr. Thomas' paper before it was published, and also for valuable suggestions in the course of my own investigation.

Omitting the deduction (which will be found in my *Z. f. Phys.* paper), I shall give here but the final equations, which are (5), (6) and

$$\frac{d}{d\tau}(\lambda\dot{x}_\alpha + A_{\beta}\mu_{\beta\alpha}) = \frac{e}{c}F_{\alpha\beta}\dot{x}_\beta + \frac{1}{2}\mu_{\beta\gamma}\frac{\partial F_{\beta\gamma}}{\partial x_\alpha}, \quad . \quad (7)$$

where the factor λ differs very little from the 'rest-mass' m_0:

$$\lambda = m_0 + \frac{U}{c^2} = m_0 - \frac{1}{2c^2}\mu_{\alpha\beta}F_{\alpha\beta}. \quad . \quad . \quad (8)$$

By applying these equations to the motion of a spinning electron about a fixed nucleus, it appears possible to get *with the same value of the ratio*, $\kappa = m/M = \frac{e}{cm_0}$, a correct representation both of the multiplet structure and of the (anomalous) Zeeman effect. For example, in the absence of an external magnetic field ($H = 0$) we find from (5) the following approximate equation for the *secular variation* of $\mathbf{m}$:

$$\frac{1}{\kappa}\overline{\frac{d}{dt}\mathbf{m}} = \frac{1}{2}\mathbf{m}\times\overline{\left(\mathbf{E}\times\frac{\mathbf{v}}{c}\right)} = \frac{1}{2}\mathbf{m}\times\overline{\mathbf{H}}', \quad . \quad . \quad (9)$$

where $\mathbf{H}' = -\frac{\mathbf{v}}{c}\times\mathbf{E}$ is the mean magnetic intensity in a co-ordinate system where the electron is momentarily at rest (the mean being taken for the undisturbed orbital motion). This equation differs from that of Thomas by the fact that it refers to the *secular mean* and not to the true motion; it corresponds to an apparent ratio between the magnetic and mechanical moment of the electron's spin, which is exactly equal to one half of the actual one κ, that is, coincides with the corresponding ratio for the orbital motion.

J. FRENKEL

Hamburg, March 25.

Transmission of Stimuli in Plants.

SNOW[1] has confirmed my discovery that the propagation of stimuli in the stem of the so-called Sensitive Plants is due to the transport of a hormone in the water of the tracheæ.[2] He, however, comes to the conclusion that in the leaves there is another and more rapid means of conduction of stimuli. This function he provisionally assigns to protoplasmic processes.

The idea that the same end is attained in the stem and in the leaves by two entirely different processes is difficult to accept. At the same time Bose's[3] view, which attributes the propagation of stimuli in both these organs alike to protoplasmic processes is negatived by the experiments of MacDougal, Cunningham,[4] and myself. In my own experiments especially it was rigorously proved that propagation took place across zones in which there were no living elements. Bose's statement that he cannot repeat my experiments, which were contrary to his own conclusions, may be put aside, inasmuch as my results have been confirmed by Snow and others.[5]

It is true that my experiments were principally carried out on stems. Nevertheless, two series were carried out with leaves, and proved conclusively that in these organs also the propagation of stimuli is due to the transport of hormones in the water of the tracheæ. However, when Snow brought forward new facts and interpreted them in support of his view that there are two distinct means of propagation, I determined to make a further study of the matter, as I thought it of the highest biological importance to determine whether the propagation of stimuli in plants took place by a means comparable to nervous transmission in animals, or whether it is simply and solely due to the transport of hormones.

My complete work on this subject will not be ready for publication for some time. Consequently, this is a short account of my experimental results without critical discussion. Meanwhile, I would merely state that the cohesion theory of Dixon and Joly appears to me to afford the explanation of the water movements which cause the propagation of stimuli.[6]

In 1924 I carried out the following experiments: I stripped the middle region of the pinnæ of a leaf of *Mimosa spegazzinii* of a number of its pinnules; leaving only about six pairs at the base and six at the apex. On the intact pinna there were about thirty pairs. Then one of the pinnæ was cut off and supported obliquely in a vessel of water close by the pinna still attached to the plant. When the remaining pinnules of each pinna had reopened I applied a small heat stimulus to the apical pinnules. The basal pinnules of the attached pinna quickly closed, and the stimulus often passed on to other leaves, but in the severed pinna the basal pinnules did not close, although the applied stimulus was no less; indeed, it was often intentionally greater. Similar results were obtained with *Mimosa pudica*.

Last summer I made experiments on the basipetal propagation of stimuli through a region of a petiole which had been killed. A jet of steam applied for about 10 or 15 minutes was used to kill a length of 5 mm. of the petiole. After the pinnules had reopened, a stimulus was applied by burning the apical third of a pinna—sometimes somewhat more. In every case the stimulus was transmitted to the primary pulvinus and nearly always could be traced beyond that by the responses of other leaves. Snow, who failed to get this result, assigns the success of Haberland[7] and Fitting[8] in similar experiments to the transport of sap from the killed cells, and considers this type of transmission quite different from that occurring in normal leaves. This interpretation is negatived when one compares the velocities found in normal leaves, which have been selected as being as similar as possible to the experimental leaves. In the first column of the following table are shown the velocities (in cm. per min.) of propagation in these experimental leaves compared with the velocities observed in the similar normal leaves. In the second column the velocities of propagation of the stimulus in the stem after it had passed from the killed portion of the petiole, compared with that observed in the stem supporting the normal control leaf, are entered

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[1] *Proc. R.S.*, B, 1924, vol. 96, p. 349; 1925, vol. 98, p. 188; NATURE, 1925, vol. 115, p. 82.

[2] *N. Giorn. Bot. Ital.*, 1916, vol. 23, p. 51; résumé in *Arch. Ital. de Biol.*, 1916, vol. 65, p. 219.

[3] NATURE, 1925, vol. 116, p. 576; *Proc. R.S.*, B, 1925, vol. 98, p. 190.

[4] *Bot. Gaz.*, 1896, vol. 22, pp. 296, 297.

[5] *Beitr. z. allg. Bot.*, 1923, vol. 2, pp. 260-262; *Zeitschr. f. Bot.*, 1925, vol. 17, p. 260 and p. 261. I am informed that, also in Oxford, the passage of a stimulus across an organic discontinuity in the stem has been demonstrated.

[6] NATURE, 1924, vol. 114, p. 626.

[7] "Das reizleitende Gewebesystem der Sinnpflanze," 1890, p. 36.

[8] *Jahrb. f. wiss. Bot.*, 1904, vol. 39, p. 511.

Table.

	Velocities in Leaf.	Velocities in Stem
Experimental Plants	93, 75, 48, 65, 90	9, 3, 3, 3, 15
Normal Controls	96, 102, 80, 110, 160	6, 4·5, 6, 7·8, 24

Here it is evident that the velocity in the experimental and normal leaves are of the same order, while those observed in the stem are much smaller. This difference finds full explanation in the difference of the cross-section of the conducting wood in the two organs. The fact that the velocity in the leaves having killed zones in the petioles is generally less than that observed in the normal ones may be explained as due to changes brought about in the wood by the application of the steam. Probably the most important of these changes is the development of water vapour in some of the tracheæ.

Snow found that the velocity with which colouring matters rise in the stem corresponds fairly with that of the propagation of stimuli. Last autumn I also carried out similar experiments with *M. spegazzinii*, making use of eosin. When cut branches are transferred from water into a solution of that dye, the colouring matter rising in the stem acts, in most cases, as a stimulus, and it is possible to follow its rise by the consecutive fall of the leaves from the base to the apex of the stem. In a dozen cases immediately as a pulvinus responded I cut it across and found the eosin already arrived. This method is not applicable to tertiary pulvini, which are in general less sensitive to eosin. In order to meet this difficulty, I added a good stimulant (an extract of the long shoots of *Stigmatophyllum littorale*) to the eosin solution, making up the concentration of the latter to 5 per cent. This solution was applied to the cut end of a branch, and usually the lowest leaf of this branch was the subject of these observations. As soon as the topmost pinnules of a pinna of this leaf had closed, I cut off the terminal portion (4-10 mm.) of its rachis with a scissors and examined it to see if the colouring matter had reached it. At the same time stop-watch observations gave the velocities of the propagation in the stem, the leaf, and the pinna. The results showed clearly that the stimulus is transmitted, alike in the stem and the leaf, by means of the water current. Out of 37 experiments, in one only was the eosin not found in the tip of the pinna. In all the other 36 cases a simple lens was sufficient to show the eosin on the cut surface of the apex of the pinna. Among these there were cases in which the pinnules from the base to the apex closed in 5, 4, 3½, 2½, 2 min. In these cases, whether one applies cutting or heating as the stimulus, the tension previously existing in the water of the conducting tracts must disappear owing to the rapid motion of the liquid. The neutralisation of the tension must follow the immission into the waterways of the sap of the responding cells, namely, those of the tertiary pulvini of the pinnules which close one after the other. The coloured liquid containing the hormone is present effectively in the tracheæ of the leaves even beyond the level of the motor organs which have responded, as other experiments demonstrated to me; and, in certain cases at least, the sap expelled by the responding pulvini, containing in all probability the hormone, helps in the propagation of the stimulus.

In another set of experiments I bent down a piece of a branch supporting a leaf into a shallow vessel of eosin solution. I then cut across the petiole under the liquid. At the moment of the closing of the topmost pinnule, I cut off a small apical portion (4-8 mm.) from its rachis. Of 12 such experiments, 11 showed the eosin present in the cut surface of the apical region. For this experiment I used a more concentrated eosin solution to allow for dilution caused by the exudation from the cut 'Schlauchzellen.'

In other experiments I bent down the tip of a leaf very gently into a solution of eosin and then cut it while submerged. Microscopic examination then showed that the eosin arrived at the base of the last pinnules as they closed. Sometimes the presence of the dye in the transverse section of the rachis of the pinna might be observed with a simple lens, but sometimes it required a compound microscope to reveal it. By using a more concentrated eosin solution (30 parts in 100) it was possible, in nearly every case, to demonstrate that the eosin arrived simultaneously with the stimulus, at the bases of the pinnules of the adjoining pinna.

Ubaldo Ricca.

Genoa, Italy.

Experiments in the Shaping of Wood with Flint Implements.

The discovery (Nature, January 9, 1926) made during my archæological excavations in 1925 of an ancient wooden structure, induced me to carry out some experiments in the shaping of wood with flint implements. So far as I can ascertain, this matter has not been investigated extensively, and the results of my work may therefore be of some interest. The flint implements used in these experiments were flaked by me with a quartzite hammer-stone, and comprise—an axe (Fig. 1, B), planes (Fig. 1, A and D), a pointed specimen (Fig. 1, C), and a flake with thick back, and more or less straight cutting edge. The axe was mounted[1] along the dotted line shown in Fig. 1, B, in a split stick about two feet in length, and I found that with this weapon I could detach branches up to three inches in diameter from trees without any great difficulty. The axe is flaked on one side only. On the side not figured, unflaked

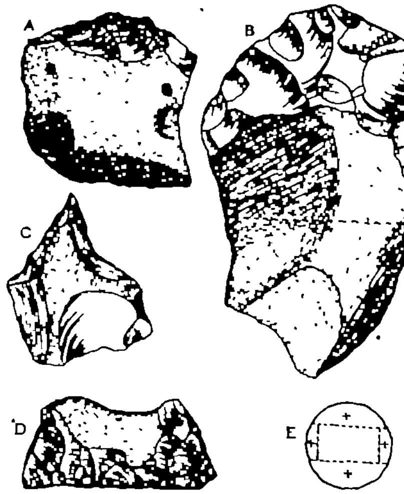

Fig. 1.—Flint implements made by Mr J. Reid Moir and used in the experiments described. A and D, planes; B, axe which was shafted along the dotted line; C, point used for boring; E, section of branch from which specimen shown in Fig. 1, C, was formed; the continuous and dotted lines, enclosing crosses, indicate the four pieces which were split off the original branch. Reduced to ½.

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[1] The stone was kept in position by string tightly bound round the split portions of the stick.

cortex is present, but this fact made, apparently, little or no difference to the cutting powers of the edge.

The specimen shown in Fig. 2, B, is part of the branch of an apple-tree which was detached with the axe described, and shaped roughly to the form of a pointed stake, such as was found supporting the wooden structure above mentioned (NATURE, January 9, 1926). It will be remembered that this structure was formed of two pieces of oak, of plank-like form, evidently split off from a trunk of considerable size, and I was anxious, therefore, to see if it were possible to produce, with flint implements, a piece of wood of plank-like form, from a branch with a more or less rounded section. The result of my attempt to do this is illustrated in Fig. 2, C, and it will be seen that I was successful in my efforts. The branch was first of all split longitudinally four times with the axe, so that the outer, rounded surface was removed (Fig. 1, E), and the specimen thus caused to assume an approximately plank-like form, oblong in section. The wood, which is part of the branch of an apple-tree, was then further modified to the desired shape by means of the planes shown in Fig. 1, A and D, which were also used in smoothing down the point of the stake illustrated in Fig. 2, B. The piece of deal (Fig. 2, A) was perforated by means of the pointed implement (Fig. 1, C), the operation being carried out from both sides of the wood alternately, while the specimen shown in Fig. 2, D, represents a branch of an elm tree which was sawn through with a flint flake, the cutting edge of which I did not provide with 'teeth.' With the exception of the axe, which was mounted, all the other flint implements were held in the hand when in use.

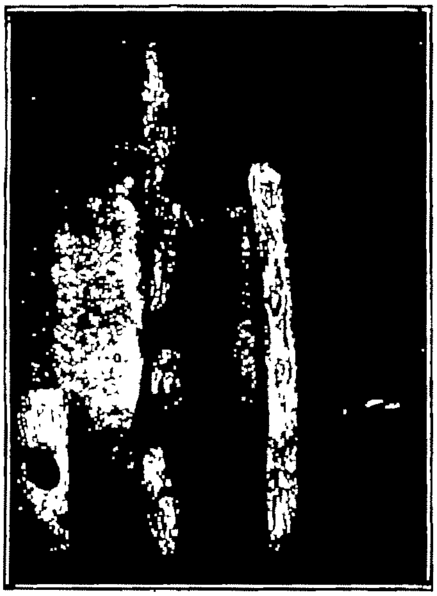

FIG. 2.—Specimens of wood shaped with flint implements. A, piece of deal perforated by flint point; B, branch of apple tree pointed—note cut indicated by arrow; C, apple wood shaped to a plank-like form from a more or less circular branch; D, branch of elm sawn through with a flint flake. Reduced to about ¼. Photograph by the Curator, Ipswich Museum.

The simple experiments I have been able to carry out have convinced me that with suitably shaped flint implements it is possible to do most things in the rough shaping of wood that can be done with steel tools. Further, it appears to me at present very difficult to distinguish, in the majority of cases, between wood thus cut by flints, and that which has been roughly shaped by steel. In this regard I would direct attention to the cut (indicated by an arrow) in Fig. 2, B, and resulting from a blow with the flint axe (Fig. 1, B). This incision is, however, so narrow and 'clean' that I cannot see how it is possible to differentiate between it and a cut produced by a sharp steel hatchet. I found that the shaping of these pieces of wood, though not actually difficult, was nevertheless a very slow process, as may be judged from the fact that it took me about half an hour to perforate the piece of deal shown in Fig. 2, A.

It would seem probable that prehistoric man, from the earliest times, utilised wood for making into implements and weapons, but it is only under exceptional geological conditions that any examples of this material would be preserved till the present day. The experiments I have carried out have demonstrated to me that very many of the ancient flint implements, referable to every phase of the Stone Age, which have been found, are admirably adapted for the shaping of wood and similar material, and I feel that these practically indestructible flint implements represent, as it were, merely the 'insoluble residue' of prehistoric industries, of which the other and more friable artifacts have disintegrated and disappeared during the great periods of time that have elapsed since they were made. If this surmise is correct, then the flint implements of ancient man give us, perhaps, but a very small and imperfect picture of his state of civilisation.

J. REID MOIR.

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Relation of Weight to Height during Adolescence.

MY friend, Mr D. Caradog Jones, who during his stay in Manchester was my collaborator in the anthropometric work which has been carried on at the Manchester Grammar School for so many years, has directed my attention to his contribution to NATURE of April 10, and has asked me to make some further comments. I gladly do so, partly as an acknowledgment of the help which he so unstintingly gave me and partly because I am also indebted to Prof. Dreyer for the interest he showed in 1921 in the work at the Grammar School, and the help I have gained from his numerous attempts to connect body measurements with accepted standards of body metabolism.

The formula to which Mr. Jones directs attention was first brought before my notice by Dr. James Kerr of the London School Board in 1911, when he was searching for a method of expressing mathematically the degree of nutrition of young children which was noticeable to the eye of the medical observer. Mr. Jones has applied this formula to adolescent children, among whom Livi claims that the result becomes constant for the 'mean' boy. It is, however, evident that the constant which Livi obtains is somewhat different from the constant obtained from the Grammar School boys. In studying the application of various formulæ I have felt to an increasing extent that the greatest difficulty in accepting any special one is due partly to the fact that the human body is built to do several entirely different kinds of work and that it develops therefore in a different way under different conditions. The apparent uniformity that is obtained by Livi's formula may be due to the fact that only two factors are taken into account, and that other factors, however essential to school anthropometry, are left out of account, particularly chest circumference, on which Dreyer himself lays stress in his "Assessment of Physical

Fitness," which affords information both of body build and respiratory reservoir.

I am by no means certain, however, that the physical framework and the mechanical output which fit a boy to be a long-distance runner is the same as those which fit him to be a good swimmer or a good gymnast, and there is good ground for believing that the good scholar in any given population is better, physically as well as mentally, than the poor scholar in the same population, but that this superiority may not be so manifest when we are dealing with another population. Even the accepted constant relation between body surface and body mass that is adopted for basal metabolism provides us with only a limited basis for judgment when we consider the metabolism of different forms of active life We find that the area of the body surface, even as calculated from the mass, affords only a limited knowledge of the function of the skin and its capacity for heat radiation or the elimination of perspiration. All that one can hope from any of these formulæ is a basis for calculating variations in a particular population. They do not, I think, provide a standard of proper growth suitable for all conditions, nor do I think any uniform standard can be found applicable to all classes and races after adolescence is established.

So long ago as June 1899, NATURE published some very remarkable grading charts of a group of public school boys of an earlier generation by Mr. Cecil Hawkins, which enabled one to calculate the relative variations from the 'mean' of different boys in height, weight, and chest girth at successive ages Graphs based on these illustrating special types of physical development were given in an article in the *School World* in August 1903. Mr Hawkins' grading tables were in use at this school from 1909 until 1921, and have proved of inestimable value in studying the growth of individual boys in different directions With the help of similar tables applicable to more recent conditions, but based on expected time increments of growth, which Mr Jones has drawn up for Grammar School boys from figures calculated by Matthew Young, I have been able to compare the body build and the body metabolism as indicated by vital capacity of boys distinguished in different forms of athletic exercise, *e.g.* long-distance running, sprinting, swimming, gymnastic competition, high scholarship, and also a group of boys of retarded scholarship, and I think this method of comparative or composite graph affords us the basis for a convenient expression of our judgment of any particular boy. With the help of Dr. P. Brooke Mumford I am now organising at Manchester Grammar School schemes for the differentiation of the degree of development of the heat-eliminating powers and response of the skin to timulation, and the relation of these powers to physical build and to output of activity. I hope to publish a complete statement of the anthropometric research done at the Grammar School since 1909 during the coming autumn.

ALFRED A. MUMFORD,
Medical Officer

Grammar School, Manchester.

The Use of Arcs and other Fluctuating Sources in Photoelectric Photometry.

IN his paper on the registering microphotometer, P. Koch (*Annalen der Physik*, iv. 39, p 705, 1912) escribes an arrangement consisting of two similar hotoelectric cells connected to an electrometer, both luminated by the same source, but through different ptical paths The arrangement described has the advantage of being independent of intensity fluctuations in the source (provided that these are uniform over the area of the source), since the electrometer reading depends only upon the *ratio* of the intensities falling on the two cells. An example is given in which a change from 10 to 100 in the light intensity of the source produced only a 1 per cent. change in the electrometer deflexion. However, it remained impossible to use arcs, or other light sources which not only fluctuate in intensity but also flicker or change their position ; for since the two beams come from different parts of the source, and traverse different optical paths, flickering changes the ratio of their intensities, as well as the absolute values.

It is the purpose of this note to point out that in most cases the optical paths to the two cells may be made practically identical by using a partially reflecting plane mirror to divide the beam The arrangement is shown in the diagram below (Fig 1). S is the source (a carbon or mercury arc, for example) ; the purpose of the lenses L and L' is obvious , TR represents an optical train of any kind (lenses, prisms, filters, polarisers, etc) , M is the partially reflecting plane mirror, C_1 and C_2 the two similar cells, and, before C_1, F, the filters, photographic plates, crystals, analysing nicols, etc , the variable transmission or absorption of which it is desired to measure (The electrical connexions of the cells and the electrometer, etc., are not shown , they are described in detail by Koch, *l.c*) Under these conditions flickering and wandering of the light source will alter both intensities in the same ratio, provided that the variable absorber F takes the full beam of light; that is, requires no further diaphragms. This will be true, for example, in measuring the absorption of filters, large crystals, large areas of a photographic plate, etc.

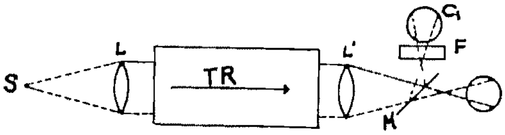

FIG. 1

If the variable absorber F requires a diaphragm, troubles may arise, due to the fact that fluctuations may change the distribution of energy over the cross-section of the beam of light. The intensity of the beam diaphragmed out may then change, whereas that of the full beam going to C_2 does not There are then two alternatives : if the diaphragm in F may be removed some distance from the absorber, the dividing mirror M may be placed between the diaphragm and the absorber; but if, as in the microphotometry of spectral lines, the diaphragm must be very close to the object the transmission of which is to be measured, an attempt must be made to diaphragm the beam going to C_2 in an exactly similar manner, so that the two diaphragms or slits are situated at corresponding points of the cross-sections of the beams (which, fortunately, are themselves similar). How well this compensation will succeed depends on the fineness of the slits, on the optical system, and on the constancy of the light source.

The proper ratio for the intensities of the two beams is determined by the experimental conditions. It can be altered at will by interposing a uniform filter before either cell. One must of course take precautions to ensure that the variations in the intensity of the source are not too great. From Koch's data, and from results obtained in testing the present modification, variations of even several hundred per cent are permissible.

Thus it is possible to use arcs and similar light sources giving high intensity in all regions of the spectrum for a large number of problems involving photoelectric photometry.

B. KURRELMEYER.
(National Research Fellow.)

Jefferson Physical Laboratory,
Harvard University,
March 27.

International Phenology.

THE list of thirty-one plants given in NATURE for March 20, p. 413, for which observations are requested, is singularly unfortunate for the British Isles, as fifteen are cultivated or alien; these, though four trees may be approved, are thus prejudiced for real scientific use.

It seems regrettable also that a list should be launched for scientific use that ignores botanical nomenclature and relegates a small letter to the specific or trivial name of those plants in which the former generic name is preserved; there are twelve such errors, besides two for insects.

F. A. BELLAMY.

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MR. F. A. BELLAMY'S letter directs attention to a point which might be considered a weakness in our selection of flowering plants for international phenology; but for this there was a reason which seemed prepotent.

Forty-six plants were first selected and their presence on the lists from the ten countries carefully compared. With very small exception these lists include a heavy proportion of cultivated plants. In one it was almost entirely so.

Of the eleven selected from the chief list in our own schedule (observed systematically for thirty-five years) there is only one, the horse chestnut. (By a printer's error its asterisk was transferred to the lilac.) Numbers 1 to 3 come in our supplementary list. Hence we felt compelled, in selecting the balance of seventeen, to consider our colleagues abroad by including ten further cultivated or alien kinds, making a total of fourteen out of the thirty-two.

The intentional omission of capital letters for all specific names, even where originally generic, was perhaps open to criticism. But is there not a growing tendency to adopt this simplification?

I am glad to have the opportunity of correcting an error in the reference to the "late" Prof. Vanderlinden in the letter in NATURE of March 20. Fortunately, Prof. Vanderlinden is still alive and active.

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Secy. Phenological Committee of the
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Transfer of Excited Energy from Ozone to Hydrogen and Nitrogen.

RESULTS have been obtained by Venkataramaiah (*Jour. Am. Chem. Soc.*, 45, 261, 1923) which show that hydrogen is activated by continuous burning of oxygen in hydrogen. He considers that the reaction activates the hydrogen. Probably electrons of high kinetic energy, capable of ionising the hydrogen, are emitted by the reacting molecules. In considering this theory further it seems probable that ozone might play a part in this reaction as ozone is formed in flames, and also decomposing ozone emits radiation of very short wave-length as shown by Stuchety (*Zeit. w. Photochem.*, 19, 161, 1920). The energy corresponding to the radiation emitted is greater than the energy of ozone decomposition.

It has been shown by Grubb (NATURE, 111, 671, 1923), and Venkataramaiah (NATURE, 112, 57, 1923), that active hydrogen produced by electrolysis will combine with molecular nitrogen with the formation of ammonia. If ozone emits energy enough upon decomposing to activate the hydrogen, then in the presence of nitrogen we might expect that the active hydrogen would combine with nitrogen to form ammonia.

To test this, the following investigation was carried out. A solution of sulphuric acid, sp. gr. 1·213 at 15°, was electrolysed using a current of 6·2 amperes. The drop of potential across the electrodes was 9 volts. A piece of platinum foil 5 sq. cm. in area served as a cathode. The anode was a platinum wire 0·5 mm. in diameter and 35 mm. in length. A stream of ammonia-free hydrogen and nitrogen at atmospheric pressure, mixed approximately in the ratio of three to one respectively, and at a velocity close to eight litres per hour, was led directly down over the anode at which the ozonised oxygen evolved at a very rapid rate. The escaping gas mixture passed through a tube two feet long and was washed with ammonia-free water in an extremely efficient absorption bulb. Runs of fifteen minutes' duration were made. Then upon Nesslerising the absorbing liquid a heavy precipitate was obtained. To obtain a quantitative estimate an aliquot part of the absorbing liquid was taken for Nesslerisation. If the velocity of the hydrogen-nitrogen mixture was increased, less ammonia was formed. A further study is being made of some of the factors involved.

A. C. GRUBB.

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Domestic Heating.

IT is curious that a lady of Dr. Marie Stopes's scientific eminence should not have taken more trouble to inform herself upon this subject before writing upon it in NATURE (March 6 and April 24). In the first place, the difference in tonnage of coal used in domestic fires (40 million) is not insignificant in relation to that used in industry (100 million), and in the second place (apart from Dr. Stopes's personal sensations) the radiant efficiencies of electric radiators, gas fires and coal fires are, according to Dr. Margaret Fishenden, in the ratio of 5 : 3 : 1 For my sitting-room I prefer to use coke, and in the bedroom gas fires or electric radiators, all of which are smokeless—a very desirable matter.

Low-temperature coke is not yet a commercial success though it may become so. Meantime, are we to continue to pour out literally many millions of tons of filthy soot into the atmosphere which cannot but affect the health of every town dweller because Dr. Stopes believes "a glowing coal fire gives out something subtle, yet intensely 'nourishing' to the system"?

J. B. COHEN.

1 North Grange Mount,
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April 24.

Radio Communication and Imperial Development.[1]

By Dr. W. H. ECCLES, F.R.S.

THE British Empire is a medley of fragments spread as if by blind chance over the habitable portions of the globe. Looked at in Mercator's projection, it is like a broken potsherd on the floor—a collection of large pieces and small pieces, at all distances apart. Yet, scattered as they are, these pieces of earth bear populations which instinctively turn to the mother country as the centre of that world which lies beyond their immediate interests. This is as true of the large pieces as of the small.

For so dispersed a family, the problem of telegraphic communication is important and difficult. Until the year 1902, long-distance telegrams were all carried by cables, under the sea or under the ground, and by wires on poles; and the task of serving sparsely populated and distant regions required capital outlay beyond reason. But between 1902 and 1904, in a series of bold experiments, Marconi proved that messages could be conveyed thousands of miles by telegraphy without wires. Then he and many others showed that electric waves can pass over mountain chains, and even far round the bend of the globe, at any rate at night, and that they could be picked up simultaneously in all directions round their source. Here obviously was a heaven-sent gift to the British Empire, for by wireless telegraphy we might now hope to communicate, simultaneously if desired, with a thousand places to which cables and wires could never be run.

Quite early in the development of wireless telegraphy, the principal nations began to apply it and to regulate ts employment. Indeed, control was compelled, in the armed camp that Europe then was, by the consideration hat, when war came, wireless would be useful to fleets and armies and dangerous in the hands of spies. In peace time, even, some degree of control was called for to reduce interference, especially between powerful ong-range stations. Each such station ought, in fact, o transmit on a different wave-length from other tations; and once a wave-length is assigned to a particular long-range station, it should not be given to any other. In other words, the grant of a wave-length o a powerful station is equivalent to giving a right-of-way to that station. For all these reasons the Imperial Conference of 1911 declared that wireless communication within the British Empire should always be regulated with especial care, and that, in the main, the necessary stations should be State-owned and State-perated.

This decision being given, it only remained to erect the stations. In 1912 Parliament approved a contract which the Post Office had made with the Marconi Company for the erection of a British Imperial chain of ix stations. This contract was, however, modified fter a technical inquiry, and a new contract was ratified y the House of Commons in 1913. But the engineers ad barely time to erect a few masts at Leafield in Oxfordshire and at Abu-Zabal near Cairo, when the ontract was dissolved, principally on account of the advent of war. In contrast with our inaction, the United States had meanwhile pressed on with the construction of several large government stations, and France and Germany made great progress with their respective colonial plans. Perhaps we could afford to delay. Compared with Germany, for example, we possessed elaborate cable communications, and were more confident about defending them in every sea than Germany could be. But the result was that when war broke out in August 1914, no unit of the much-discussed British wireless chain had been erected.

Germany, on the contrary, had made great strides with her colonial communications between the years 1912 and 1914. She had established thoroughly modern stations in Togoland, in German East Africa, in German South-West Africa, and in the Pacific. The three African stations could inter-communicate with one another, and, to a limited extent, with the great station at Nauen, near Berlin. The Pacific station was at Yap in the Caroline Islands. It was a noteworthy coincidence that all these stations were completed just before the War began. I remember hearing the early trial signals from Yap while I was sailing across the Pacific in July 1914. No doubt this station was intended to receive instructions from Berlin, and retransmit them to island possessions, such as Apia in Samoa, and to naval and mercantile vessels in the Pacific and the China Seas. It may be of interest to recall the fate of Yap; it is wrapped up with the story of the German Pacific fleet commanded by Von Spee, which, months later, met Cradock at Coronel and Sturdee at the Falkland Islands. I remember some of the story because I was called from Sydney to Melbourne by the Australian Government to help in an advisory way with an interesting application of wireless. At this moment the German fleet was cruising to the north of Australia and was in nightly touch with Yap. As soon as this was observed, each of the small shore stations along the Australian coast was instructed to listen for the signals of the German fleet, to record the strength with which the signals were received, and to report daily to Melbourne. From these reports, by a process resembling triangulation, an estimate was made in Melbourne of the changes of position of the fleet. Meanwhile a British naval force had set forth with the object of destroying the wireless station at Yap. This was duly accomplished, and for days afterwards the Germans, unaware of the disaster, continued to call the dead station, in vain. These continued calls, by helping us to keep track of the fleet, eased the anxiety of those who knew that the New Zealand expedition was then well on its way to capture Samoa. Thus ends the story of Yap; that of the other German colonial stations was similar.

During the War our wireless energies were deflected from the building of great stations to producing relatively small outfits for fighting purposes. War telegrams were handled sufficiently well by the cables and the wireless stations of the Admiralty, and the War closed without any progress in imperial wireless. Meanwhile the French government had erected powerful stations at Nantes, Lyons and Paris, and smaller stations in their African territories; the Italian government had erected a large modern station at Rome;

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[1] From a Friday evening discourse, entitled "Wireless in the Empire," livered at the Royal Institution on April 30

and the United States government had completed half-a-dozen big stations, together with a magnificent one near Bordeaux which was afterwards purchased by the French government. But the governments of the British Empire, at the close of the War, stood possessed of only one fairly large wireless station among them—that at Windhuk in German South-West Africa—captured by the forces of the Union of South Africa under General Smuts. Thus at the end of 1918 the British Empire was far behind most other great Powers as regards government-owned stations, and, by the way, equally far behind as regards powerful commercial stations.

At this time Lord Milner took up the cause of Imperial communications. Lord Milner appears to have been the only elder statesman of that day convinced of the imperial value of widespread communications, and aware of our national backwardness. But he looked for much more than mere duplication of cable- and land-line services. He envisaged the possibility of radiating daily from England and other great centres news and opinions of imperial interest in such a form that they could be picked up, perhaps after re-transmission by outpost stations, anywhere. He thought it wrong to continue to leave a large proportion of the population of the British Empire as isolated as if cast away on a raft in the ocean. I believe he thought that wireless would be as useful for the cultivation of mutual understanding as for strategy and commerce. In other words, he realised fully the importance of propaganda, and holding these views, advocated government expenditure on improving radio communications.

Within a year of the conclusion of the War, Lord Milner appointed a committee, under the chairmanship of Sir Henry Norman, to investigate afresh the problem of establishing a comprehensive wireless network. The committee found that the progress made in wireless during the War had completely changed the outlook. Plant was now available of at least double the effectiveness of the pre-War wireless chain proposals. Accordingly the Norman committee recommended that wireless stations of about 250 kilowatts power, giving 120 kilowatts of continuous wave power to the antenna, should be erected in Egypt, East Africa, South Africa, India, Singapore, Hong Kong and Australia, with, possibly, similar stations in Canada for trans-Atlantic and trans-Pacific communication; and that a station of double the power of the others should be erected in England. Stations such as these, it was thought, would each be able to communicate at all hours with its nearest colleague even under the very bad conditions that afflict wireless reception in the tropics; and each would communicate with its most distant colleague during at least a few hours daily. The scheme ensured that each point would communicate with every other at all times; directly when conditions were good, indirectly—that is, by the relay or passing-on principle as used in cable telegraphy—when conditions were bad. The English station being the most powerful of the network would have the maximum amount of direct communication with all. Besides this, the scheme would enable the Admiralty to transmit instructions from Whitehall to ships afloat anywhere, a requirement included in the terms of reference of the committee.

At this date there were no wireless stations in existence as powerful as those recommended, and, therefore, it was difficult to forecast what their performance would be. Moreover, the committee recommended that the stations should be equipped with thermionic valves. Now the largest valve station then known was of less than 20 kilowatts output, so the recommended English station was to be more than twelve times as powerful as its largest predecessor. The report was, clearly, somewhat ahead of its time, but not, I think, too far ahead. For by the year 1925, only five years later, the Post Office station at Rugby has been built with thermionic valves yielding double the output recommended by the committee. The Rugby station has shown besides, during the tests of the past few months, what the Norman committee's stations could have done. For example, the station recommended for South Africa would have communicated direct with England, Australia and India many hours each day, and the English station would have worked direct to the antipodes more than twelve hours daily.

Lord Milner on receiving the report was, I believe, especially pleased that stations were proposed for some of the dependent Colonies, such as East Africa, Singapore and Hong Kong; not merely because they would serve at times as telegraphic links between England and some of the great Dominions, but as ends in themselves. These intermediate stations would bring great areas of new country into closer touch with all other parts of the Empire. Lord Milner was convinced that the dependent Colonies had for many years past been neglected, and that wireless telegraphy would help to alter this state of things. So at the end of 1920 the Cabinet appointed the Wireless Telegraphy Commission, of which Lord Milner became chairman and officially assigned to it the task of getting as much done as it possibly could.

As no station could be erected until the requirements of all parties could be co-ordinated, the first task was to obtain unanimous consent to the scheme or a modification of it. It was unfortunate that Lord Milner retired from political life before any decisions were reached by the Dominion Governments. As it turned out, each Dominion Government held a differen view about Imperial wireless, partly as to the financing and management of it, partly about the technica requirements and possibilities. The only common element was that they each desired to communicate with England without intermediate steps. Thus a fast as each Dominion settled its policy, a new compromise had to be framed for the Cabinet's approval. Finally, when Mr. Amery was chairman of the Imperia Communications Committee in 1923, Empire wireless took a new spring. The Government decided to erec in England without further delay a wireless station powerful enough to transmit almost continuously to all the Dominions and dependent Colonies, and to all ships of the navy and the mercantile marine whereve they might be.

The time of waiting had not been lost. The Commission had proceeded a long way with the plans o a large station, and the Post Office engineers ha gained much experience by equipping with up-to-dat plant the medium power stations at Leafield and Ab Zabal, remnants of the old Imperial scheme of 191 As a consequence the erection of the Rugby station the most powerful in the world, has gone forward with exemplary smoothness and without accident or failure of any kind. The Rugby station when in full swing will probably be able to transmit simultaneously three long-distance telegrams and a telephone message. The ultimate aim of the telephone section is to connect any telephone subscriber in Great Britain to any subscriber in the United States and Canada. By aid of the telephone circuits already constructed between England and the Continent, it may be found possible later to connect any one in western Europe to any one in North America through Rugby.

When it is realised that this multiple service station has cost only about half what the single service station near Bordeaux cost in 1919, one appreciates the great strides that wireless design has made during the past few years. Rugby, in fact, has cost about 400,000*l.*, much less than even the new stations at St. Assise near Paris and on Long Island near New York. Further, as the Leafield station began to earn, within a year of its opening, more than covered its working expenses, so we may reasonably look forward to the Rugby station soon becoming a profit-earning concern.

It has always been obvious that the telegraphic traffic to and from the centre of the British Empire will be greater than that to and from any of the Dominions; for the centre has to deal with all the Dominions, all the dependencies and with distant shipping. The spokes all meet at the hub of the wheel. Therefore Britain must make much greater provision than even the largest Dominion, perhaps tenfold. Definite recommendations for the erection in England of stations additional to Rugby were made in the report of the Imperial Wireless Telegraphy Committee, February 1924, presided over by Sir Robert Donald. An opportunity of meeting the recommendations came in the summer of 1924, when the British Government, finding the majority of the Dominions would probably agree to use the Marconi beam system, made a contract with the Marconi Company which will result in the establishment of duplex beam circuits between Canada and England, Australia and England, South Africa and England, and India and England. The arrangement promises a happy solution of many long-standing difficulties. These beam stations are now nearly completed. A transmitting station at Bodmin serves Canada and South Africa, and a station at Grimbsy serves both Australia and India. Corresponding stations are being erected in the four Dominions.

The beam stations may claim to send their messages straight to the desired objective since the guaranteed angle of concentration of the waves is 30°. There is the additional advantage that little power is consumed, partly because of the concentration and partly because short waves are used. This again implies small capital outlay, so at first it was thought that suitable beam stations would be very inexpensive. In practice the engineers met many snags, and it is probable that the English beam stations for communicating with four Dominions will cost altogether about half as much as Rugby. For this expenditure good communication is guaranteed for a daily average of 18 hours with Canada, 7 hours with Australia, 11 hours with South Africa, and 12 hours with India.

It has been suggested that beam stations may some day supersede the wireless stations which send their waves all round. This kind of controversy is always going on in wireless and other progressive sciences, and sometimes tends to cripple action to-day by promising cheaper alternatives to-morrow. As an example, when the motor-car gained its first successes we were told that railways were obsolete; but one can still travel by train from London to Edinburgh more comfortably, more cheaply, and more quickly than by car. As regards the wireless problem, the present beam stations are the first of their kind and have not yet been operated. We only know enough to say that both systems will be useful, and that each can do something the other cannot.

Before the end of this year the long-range wireless transmitting equipment of the British Empire will include—

(1) The multiple station at Rugby, comprising:
  (*a*) Long wave plant of world-wide range.
  (*b*) Long wave plant of medium range.
  (*c*) Short wave plant of world-wide range.
  (*d*) An experimental telephony plant of range 4000 miles.
(2) Medium power stations using long and short waves at Leafield, Oxfordshire, and at Abu Zabal, Egypt.
(3) Four duplex beam circuits for communication between England and the four largest Dominions.

Thus by the efforts of the engineers of the Post Office and the engineers of the Marconi Company, the British Empire will shortly possess the most up-to-date wireless equipment in the world.

So far I have dealt with things nearly completed, but now I must indicate briefly what has yet to be attempted and is within reach. In the first place, there are important communities still unprovided with long-distance wireless; for example, New Zealand. This urgent necessity was emphasised in the report of the Donald committee. In the second place, preparations ought to be made to utilise fully the new facilities. For example, twice a day Rugby transmits a summary of news prepared by the Foreign Office, and conceivably other news services may be arranged. If I were a settler in Uganda or the owner of a remote sheep station in Australia, I should install a simple receiving set and so keep in touch with the world. But this implies learning the morse code, not so hard as learning to use a typewriter, but still a difficulty; and therefore in small communities where there is a local news sheet, it would be more practical to organise a receiving service by paying an operator to listen regularly and decode the messages for the printer. In the British Empire there are innumerable remote settlements to which the cabled news messages leak very slowly, and there are many which depend entirely for their news on the occasional visit of a ship. All such outposts can now, by the aid of a simple receiving set, be made to feel that they are within five minutes of Fleet Street. Moreover, if these stations were registered, messages could be specially addressed to them from England just as telegrams are addressed from Rugby to-day to ships on distant oceans.

Another method of distributing the morse messages from home when received, say in New Zealand, is to announce them, after decoding, through the local broadcasting stations. In each of the Dominions such stations are growing in numbers, and by their aid messages could be distributed promptly to millions of listeners-in. Of course it may some day be possible, after further invention and development, for speech and music from England or other centres to be put on to every local broadcasting station in the British Empire.

This does not exhaust the possibilities now arising. During the past two or three years wireless amateurs have succeeded in transmitting signals and even speech across vast distances with tiny apparatus. The plant used is so small that it could be installed in a drawing-room. If only we could rely upon plant of this size getting through for days instead of hours, then there would be no need for high-power stations. Even so it is easy to imagine how such glimpses of intercommunication might be made use of in the elaboration of Empire wireless.

The chief results expected from all these efforts to establish an Imperial wireless network can be put in two sentences. Firstly, mutual trade will be facilitated by rapid and cheapened communications, and finance will benefit by a shortening of credit such as followed the introduction of the cables. Secondly, the interchange of opinion between all sections of the British Empire will become fuller; and just as wireless on the small scale has become, in the shape of broadcasting, an important social influence in Great Britain, so wireless on the large scale will have a similar influence in, and strengthen the unity of, the British Empire.

Segregation and Related Problems.

THE laws of evolution and heredity have generally been regarded as universal in their application both to plants and animals. The various theories of evolution have been held by their authors to apply indiscriminately to both kingdoms, and the same has been true of theories of heredity and, with certain limitations, of cellular structure and mitotic division. But there are signs in the more recent developments of genetics that these general resemblances, fundamental as they are, have been over-estimated. In the future, we may expect to see greater emphasis laid on the distinctions, many of which are also fundamental, between animal and plant structure, especially as they affect variations and hereditary behaviour.

The tendency to recognise a divergence between plants and animals in certain aspects of their genetical and evolutionary behaviour has become increasingly evident, both on the breeding and on the cytological side. This tendency is well exemplified in the recent paper on segregation, by Bateson (*Journ. Genetics*, vol. 16, No. 2), the last, unfortunately, which he published before his lamented death. It was the Leidy Memorial Lecture delivered at the University of Pennsylvania in 1922, and in it the greatest biologist, perhaps, of his generation discusses the nature of segregation and the various problems connected with it. In recent years the Merton Laboratory had made extensive studies of variegation in many plants and of various forms of somatic segregation, especially from root cuttings. These in Bateson's hands furnish the basis for a consideration of the nature and significance of the many forms of segregation observed. The fact emerges that not only are most of these forms known only in plants, but also that somatic segregation when it occurs in animals is usually quite different in genetic behaviour and significance.

The term *anisogeny* is introduced for the numerous cases now known in Matthiola, Oenothera, Linum, Campanula, Begonia, and other plants, in which the male and female gametes are carrying separate factors, and it is not clear that this is always due to the loss of one class of gametes after segregation in meiosis. Not only does the place of segregation vary in the many kinds of somatic segregation now known, but also it has been shown by Miss Andersson in the variegated hart's tongue fern that all the 64 spores of any sporangium are alike in the form of plastid they transmit, this depending only in part on the plastid characters of the vegetative tissue from which the sporangium arises. The well-known experiments with rogue peas, made by Bateson and Punnett, Miss Pellew, and others, indicates that here is an orderly type of progressive somatic segregation occurring from below upwards in the plant and accompanied by anisogeny.

Bateson returns to the presence-absence hypothesis and makes out a case for it, based particularly on the interpretation of multiple allelomorphs; for example, the yellow 'eye' series in *Primula sinensis* and the colour series in rabbits. These, as he points out, characteristically form a plus or minus quantitative series as regards one character. The quantitative interpretation of a multiple allelomorphic series is very probably correct; but even so, any advantage of the presence-absence conception appears to be merely a matter of convenience in symbolism. It is, of course, possible that all variations are in essence quantitative. We seem to be arriving at a position in which no essential difference remains between the presence-absence conception and that of each pair of allelomorphs as the result of a germinal change.

In the same number of the *Journal of Genetics*, Castle, Punnett, and Pease continue their discussion of the various types of 'Dutch' rabbits, which have taken the place of the hooded rat as material for the explanation of an apparently continuous series of variations. Castle contends that Self, Dark, and White Dutch form an allelomorphic series, together with modifying factors, while Punnett argues that Dark Dutch is the basic condition, which becomes self-colour through the addition of modifiers. It would follow that an allelomorphic series is not involved in this case; but to settle the matter finally a further study of the linkage relations may be required.

It is clear that segregation remains the central conception in modern genetics, the science which Bateson founded. But it takes a great variety of forms, particularly among plants. Their further elucidation will lead us into new fields.

R. Ruggles Gates.

New Foreign Members of the Royal Society.

LAST week the Royal Society proceeded to the election of eight foreign members, men of science distinguished in various departments. Their inclusion fills a series of vacancies, occasioned by deaths, which had arisen since 1921.

In the early days of the Society's history, it was the custom, on the election of specially notable philosophical inquirers and workers, not of English birth, to send them an ornate diploma carrying the Society's seal. Birch, the historian, records that, in 1680, "Dr. Gale was called upon for the diploma to be sent to Mr. Leewenhoeck, and it was ordered that the society's seal should be affixed to it, and that a silver box should be provided for it."

Subjoined are the names of the newly elected members with some details of their respective careers.

PROF. MARTINUS WILLEM BEIJERINCK.

Prof. Beijerinck is regarded as the foremost bacterial physiologist of his time. He was the first to isolate in pure culture the bacteroids of the Papilionaceæ and to study filter-passing viruses of plant. He began in 1884 an important series of memoirs, which were published by the Amsterdam Academy of Sciences. They dealt with photogenic bacteria, anaerobes, and kindred subjects. Two of his papers may be cited: (1) "Die Bacterien det Papilionaceen-Knöllehen" (*Botanische Zeitung*, 1888), (2) "Les expériences sur les bactéries lumineuses" (*Journal de Micrographie*, 1891).

PROF. NIELS BOHR.

Born at Copenhagen in 1885, Prof. Bohr received his academic training at the Universities of Copenhagen, Cambridge, and Manchester. At the last named he spent four years working with Sir Ernest Rutherford. Returning to Copenhagen in 1917, he gathered round him a band of helpers in attacking the complex problem of atomic structure from the spectroscopic side. Author of the conception to which the name Bohr-atom has been attached, he has made fundamental advances in interpreting spectroscopic phenomena in terms of quantum dynamics. He was Hughes medallist of the Royal Society in 1921, and received the Nobel Prize for Physics in 1922. Prof. Bohr delivered the seventh Guthrie lecture of the Physical Society, in 1922, on "The Effect of Electric and Magnetic Fields on Spectral Lines."

PROF. ERNST COHEN.

Born at Amsterdam in 1869, Prof. Cohen was formerly occupant of the chair of physical chemistry in the University of that city. He is now professor of physical and general chemistry and director of the Van 't Hoff Laboratory in the University of Utrecht. He has published many chemical memoirs through the Amsterdam Academy of Sciences and in the *Zeitschrift für physikalische Chemie*. He is distinguished for his researches on the allotropic states of the chemical elements. As a pupil and follower of Van 't Hoff, chemists owe much to him for methods by which sound foundations have been laid for physico-chemical theory. Prof. Cohen recently was elected president of the International Union of Pure and Applied Chemistry.

PROF. WILLEM EINTHOVEN.

Born at Semarang, Java, on May 21, 1860, and educated at Utrecht, Prof. Einthoven has been, since 1886, professor of physiology in the University of Leyden. Early in his career he was an assistant of Donders. He is LL.D., Aberdeen, and in 1924 was the recipient of the Nobel prize for medicine. Prof. Einthoven has devised instruments specially adapted to the study of physiology, as well as those suitable in high degree for physical researches. Important papers have illustrated and illuminated his procedure. One memoir of his may be cited, namely, "On the Theory of Lippmann's Capillary Electrometer" (1900).

PROF. KARL E. RITTER VON GOEBEL.

Born at Billigheim, Baden, in 1855, von Goebel was educated at the Universities of Tübingen, Würzburg, and Strasbourg. He is a foreign member of the Linnean Society. Elected to the chair of botany at Strasbourg in 1881, he later occupied posts at Rostock and Marburg, down to the time when he became professor of botany at the University and director of the Royal Botanic Gardens, Munich. An authority on the mosses and liverworts (Bryophyta), some of his work has appeared in English under the title "The Organography of Plants" (Oxford, 1905). He is an honorary LL.D. of the University of St. Andrews.

PROF. HENRY FAIRFIELD OSBORN.

Born at Fairfield, Connecticut, in 1857, Prof. Osborn graduated at Princeton University, U.S.A., holding there (1880–91) the assistant professorship of comparative anatomy. Afterwards (1891–1910) he occupied the chair of zoology in Columbia University, New York, and is now research professor of zoology there. Prof. Osborn is among the most distinguished palæontologists of our time. His first publication (1883) dealt with the structure of the brain in amphibia; later memoirs dealt mostly with fossil vertebrates. One of the results of his work is the more precise determination of the relative ages of the extinct mammals of North America. As director of the American Museum of Natural History, Prof. Osborn has made the institution world-famous. He has had distinctive influence in establishing a school of younger palæontologists. In 1918 he was Darwin medallist of the Royal Society. In our recent special issue relating to the centenary of Huxley (May 9, 1925), Prof. Osborn contributed an interesting article entitled "Enduring Recollections."

PROF. MAX PLANCK.

Prof. Max Planck was born at Kiel in 1858. Formerly a professor in the University of Kiel, he is now professor of mathematical physics and director of the Institute of Theoretical Physics in the University of Berlin. His outstanding achievement has been the foundation of the quantum theory—Planck's constant is now considered to be one of the fundamental constants in Nature. Planck first discovered the true law of black body radiation; then showed how this could be satisfactorily explained in terms of a system of dynamics. From this the modern quantum theory has grown, with all its far-reaching developments.

PROF. ARNOLD SOMMERFELD.

Prof. Sommerfeld was born at Konigsberg in 1868, and was educated there and at Gottingen. Formerly holding professorships at Claustal and Aachen, he is now professor of theoretical physics in the University of Munich. His book "Atomic Structure and Spectral Lines" (English edition) contains an account of mathematical work on the structure of the atom, his own contributions being of very high value.

Obituary.

ADMIRAL SIR JOHN FRANKLIN PARRY, K.C.B.

ADMIRAL SIR JOHN FRANKLIN PARRY, K.C.B., whose death occurred at Harrogate on Wednesday April 21, had a long and distinguished record in H.M. Navy, principally as a hydrographic surveyor and as Hydrographer of the Navy.

Born on August 15, 1863, Parry joined the Royal Navy in 1877, being promoted to lieutenant in 1885, commander in 1899, captain in 1905, and rear-admiral in 1916. He first joined H.M. Surveying Service in April 1884, being appointed to H.M.S. *Triton*, surveying on the east coast of England. After a short period in that ship he was appointed to H.M.S. *Rambler*, where he served from November 1884 until March 1889 in the Red Sea and Far East, receiving the Egyptian Medal and Khedive's Bronze Star for the part he took in the naval and military operations at Suakin in 1884–1885. In 1888 he was landed in command of a party at Mempakol, British North Borneo, to protect the Resident Commissioner from an attack by hostile natives. His next ships, all employed on hydrographical surveying, were the *Penguin*, *Triton*, and *Dart*, and whilst in the latter as senior executive officer he succeeded to the command of her, after two years' service, in 1897. He remained in command carrying out important surveying work in Australian waters until the middle of 1900.

From August 1900 until February 1903 Parry held the important post of Chief Civil Assistant to the Hydrographer (Admiral Sir William Wharton, K.C.B., F.R.S.), and from that post assumed command of H.M. Surveying Ship *Egeria* surveying in British Columbia, where he remained until 1906. He was then appointed in command of H.M. Surveying Ship *Merlin* surveying in the Red Sea and north-west coast of Borneo, but only remained until the end of that year, being incapacitated through sickness. He was appointed to H.M. Surveying Ship *Egeria* again in 1908, remaining with her surveying in British Columbia until April 1910, when he completed his hydrographic work afloat.

As Assistant Hydrographer from April 1910 until August 1914, Captain Parry carried out much important work in connexion with hydrography and allied subjects. Amongst other positions he represented the Admiralty on the Board of Trade Committee on Derelicts in 1912, and on the conference on the subject of the Atlantic ice patrol following the loss of the *Titanic*. He was also British delegate to the French conference on the use of wireless telegraphy in connexion with time and weather, and served as chairman of the important Admiralty Committee on the re-organisation of British Admiralty charts.

Appointed Hydrographer of the Navy on September 1, 1914, Captain Parry held this post throughout the War and until August 31, 1919. During this period the work of his Department was very largely increased to meet war requirements, and although the surveying ships employed were necessarily reduced to a minimum, the surveyors' activities afloat, and in connexion with the Hydrographer, were very much increased, and under his direction the numerous and varied calls for new forms of charts and other technical hydrographic publications were fully met. His last important work, before retiring as Rear-Admiral and from being Hydrographer, was to preside over the International Hydrographic Conference in London in June 1919, when forty-five delegates, representing twenty-five nations, met to discuss the standardisation of hydrographic charts and publications, and kindred subjects.

After retirement as Hydrographer, Sir John Parry was employed as a member of the International Hydrographic Bureau Committee until June 1921, when the Committee was dissolved; then becoming, by election, senior director of the International Hydrographic Bureau, Monaco, which post he held to the day of his death. During 1920 he was also employed by the contractors for the Crown Agents for the Colonies in making an examination of a suitable locality on the Gold Coast to determine the best site for a deep sea harbour. Sir John Parry undertook the sole charge of this expedition, and the valuable work therefrom resulted in Takoradi Bay being chosen, where the building of the new port is now well advanced.

In recognition of his services Parry was made C.B. in 1916 and K.C.B. in 1919. He also received the Cross of Commander of the Legion of Honour (France) and the Distinguished Service Medal (U.S.A.). He was a fellow of the Royal Geographical Society, being elected in 1917. He was promoted to Vice-Admiral on the Retired List on November 25, 1920, and to Admiral on November 24, 1925.

MR. F. C. L. WRATTEN.

IT is with much regret that we learn from the *British Journal of Photography* of April 16 of the death of Mr. F. C. L. Wratten at the age of eighty-six years. Mr. Wratten came from Hellingly, Sussex, when he was twenty-one, and became a clerk in the photographic firm of Solomon's of Red Lion Square. In 1877 he entered into partnership with Henry Wainwright (who died in 1882) and established the well-known firm of Wratten and Wainwright in Great Queen Street, London.

As soon as gelatine was shown to be a possible medium for photographic plates and to offer advantages that collodion does not possess, Mr. Wratten took up the matter, and as a result of his experimental investigations was one of the very first (1877) to put gelatinobromide dry plates upon the market. These "London" plates were remarkable for their fine quality although made entirely by hand.

Mr. Wratten was also a pioneer in 'instantaneous' photography by taking advantage of the superior sensitiveness of gelatine over collodion plates. In 1882 he photographed the University boat race, and he was the first to photograph the Derby. As soon as gelatine plates became fairly well established, Mr. Wratten started a plate factory at Croydon, and he lived there for the last forty-six years of his life. In 1896 the shop and premises in Great Queen Street were closed. In 1906 Dr. Kenneth Mees joined the firm, and in 1912 the Kodak Company bought the business. Dr. Mees went to Rochester, New York, to establish and conduct the research laboratories there, and Mr. Wratten's son, Mr. S. H. Wratten, became the head of a technical department of the Kodak Company.

News and Views.

ON March 9 Dr. Arthur Wade read a paper before the Institution of Petroleum Technologists in which he embodied the results of his experience of oil exploration in Australia and Papua. As he pointed out, in no part of the world have the Government and people of a country been more anxious to obtain indigenous supplies of petroleum than in Australia, but so far this natural desire has not been realised. Many geologists have concluded, and with good reason, that owing to the fundamental character of the Australian continent, and its similarity to the great Archæan shields of the earth's surface, it lacks either the marine sedimentary cycles or the tectonics with which one associates the main oilfields of the world; hence the chances of locating large oil-pools are remote. The author felt that this was a dangerous generalisation for a continent, though he admitted that very large areas in Australia were distinctly unfavourable to the occurrence of oil; he stated "the close study of a few areas of comparatively limited extent leads one to the conclusion that commercial pools of oil do occur elsewhere in association with conditions . . . (characterised by) . . . the presence of abnormal factors which operate locally and are not usually active in productive oilfield areas."

DR. WADE dealt with the various direct and indirect indications of oil in the continent of Australia, but it cannot be said that in any one instance these amount to much: South and Western Australia have nothing to offer which can be construed as being in the slightest degree favourable. Of the Northern Territory he says: "Copper, gold and tin are more certain of providing the prospector with adequate returns for his work than is petroleum." The possibilities of Queensland seem to be based on the historic find of natural gas in a water-well at Roma in 1897; but subsequent drilling has not proved successful. In New South Wales an application of the American 'carbon-ratio' hypothesis has directed attention to the Sydney coal basin; but the author himself dispelled optimism in prospects here by his careful scrutiny of the data, though he considers the chances of locating natural gas favourable. In other parts of the continent very little is known of the geological conditions, save in broadest outline, though there is apparently little to commend them as potential oil-producing areas. With regard to Papua, geological circumstances are entirely different from those of the Australian continent, and chances of locating commercial pools are much more favourable; conditions of exploration and operation are extremely difficult in this territory, but past developments have not been without some success, and now that the Government has recently abandoned its monopoly to drill, private enterprise may well be productive of satisfactory results in the course of time.

SIR JOSEPH THOMSON gave the Kelvin Lecture to the Institution of Electrical Engineers on April 22. He chose as his subject the mechanics of the electric field, a subject, he said, which was never long absent from Kelvin's thoughts. He pointed out that the ordinary laws of electro-magnetism and of the dynamics of the electric field merely represent the relations between averages taken over a time which, though small, is finite and comparable with the times that occur in the atom. These relations, however, are meaningless when times less than the times for which the averages have been taken are considered. When considering the orbits of electrons, the principle of the conservation of energy holds only when taken on the average. When electric waves are generated by an electron in an atom, the time constant of the force increases as the force becomes weaker. When the field is very intense, the time constant is very small and the ordinary equations hold. When electric radiation becomes weaker and weaker, a place is reached where the time constant is comparable with the period of vibration; when this occurs the radiation is reflected. It will not go out into space. The waves coming back to the electron will restore the energy to it which they originally received. This can be applied also to an electron revolving in an orbit and leads to a corpuscular theory of light. In this theory, light is regarded as travelling out in bundles, the energy in each bundle diminishing as it goes through space. Sir Joseph is of opinion that the isolated positive hydrogen atom may be capable of producing vibrations which are very short even when compared with the vibrations of Röntgen rays.

THE Perthshire Natural History Museum, which ranks high amongst local institutions of its kind, has been busy setting its house in order as regards its collection of Mollusca. Mr. Henry Coates has been occupied for some years past in amalgamating the interesting and important collections presented at different times by various donors, in arranging them for exhibition, and in preparing a catalogue, which is now published in the *Transactions of the Perthshire Society of Natural Science* (vol. 8). Mr. Coates has prefixed a brief history of the collection, the extent of which may be gauged by the fact that the catalogue occupies some 75 pages in 8vo. In common with all curators he complains of the great difficulties encountered in the matter of classification and nomenclature, and bewails the lack of a thoroughly comprehensive book giving a complete survey of the Mollusca, which, as he remarks, has still to be written. Among the old and new authorities cited as consulted we should have thought that Pelseneer's volume in the Oxford "Treatise on Zoology" and Fischer's "Manuel" ought to have found place. Illustrations of the exhibition cases, explaining the structure and development of the Mollusca, are given and show how admirably this feature has been carried out. The legends to the plates, however, are not quite correct. It might have been expected that the home industry carried on at their very doors would have received special treatment; but though illustrations of the old and present methods of fishing for the pearl mussel in the Tay are given, no exhibit of the growth and development of the mollusc is mentioned, an omission which certainly should receive prompt attention, since, as Dr. Boycott pointed out in these columns (Nature, vol. 114, 1924, p. 276), there is a gap in our knowledge thereof which requires filling, and, if anywhere, it could be made good at Perth.

The fourteenth International Geological Congress will assemble at Madrid on May 24-31. The principal subjects to be discussed are: (1) phosphates and pyrites, (2) geology of the Mediterranean, (3) Cambrian and Silurian fauna, (4) geology of Africa and its relation to that of Europe, (5) Tertiary vertebrates, (6) Tertiary Foraminifera, (7) Hercynian folds, (8) metallogeny, (9) vulcanism. There will be excursions before the meeting to the Straits of Gibraltar, the Mountains of Ronda, Linares and Huelva, the Guadalquivir, the Sierra Morena and Sierra Nevada, Burgos, the Canaries; during the meeting, to Almaden, the Guadarrama Mountains, Aranjuez; and after the meeting to the collieries of Asturias, the iron deposits of Bilbao, Catalonia and the Central Pyrenees, Catalonia and the Eastern Pyrenees, and the Balearic Islands. Any one desiring to take part in the Congress must apply to the Secretary of the Executive Committee of the Fourteenth International Geological Congress, Escuela de Minas, Calle de Rios Rosas, 5, Madrid, Spain, and enclose a remittance of 30 pesetas. A deposit is also required from those taking part in any of the excursions. Arrangements have been made for reduced railway fares to and from Madrid for members of the Congress on the Spanish railways, on the production of a special certificate issued by the Congress.

The issue of the *Journal of the Royal Society of Arts* for April 2 contains a paper on domestic heating by Dr. Margaret Fishenden, of the Fuel Division of the Research Department, in which the relative costs of different systems of heating are compared. Taking good household coal at 50*s*. a ton, coke at 40*s*, coal-gas at 10*d*.; a therm, and electricity at 2*d*. a unit, the prices of a therm are, for coal, 1 9*d*; coke, 1 7*d*.; gas, 10*d*. and electricity 59*d*. For central heating, coal and coke appliances have an efficiency of 50 per cent., while gas and electricity appliances have 100 per cent. The costs of the same amount of heat effect are therefore in the ratios 1 : 0 9 : 2 6 : 15·5, and coke is the most economical. For heating by radiation from a body at high temperature, open fires have an efficiency of about 25 per cent., gas fires about 50 per cent., and electrical radiators nearly 100 per cent. The relative costs of equal heat productions in a room are coal, 1*d*.; coke, about 0·75*d*.; gas, 2*d*.; and electricity, 7*d*. Labour-saving, cleanliness, intermittent use and comfort have to be considered in addition to cost, and in the discussion it was stated that for one person using fires intermittently, gas is as cheap as coal.

Southport meteorological observations for the year 1924 have recently been published by the Southport Corporation and the Meteorological Office, Air Ministry, the Fernley Observatory being now auxiliary to the Meteorological Office. Observations at Southport have been continuous for more than fifty years, so that the averages of temperature and rainfall are excellent for a health resort, and the observer, Mr. Joseph Baxendell, who is meteorologist to the Corporation, ranks amongst the foremost observers in meteorology, and commonly introduces material of much value into his annual report. The outstanding feature of 1924 is said to be a record frequency of southerly winds, and in consequence the year was very dull, decidedly wet, and fairly warm. The only months noteworthy for trying 'cold' winds were February and March. Due northerly winds were of less than normal frequency in every month except February. December was one of the mildest ever experienced. Though 1924 was wet it was less so than in many districts; there have been quite a number of wetter years and several more dull since observations were established in 1871; five of the twelve months were drier than usual, the run of rainy weather from July to October being very unfortunate. Only three months were brighter than is customary, almost the whole of the year's large shortage of sunshine occurring during the summer half year. In the appendix to the report for 1924 the periodicity for a small number of years is given from the harmonic analysis of 53 years' records of Southport rainfall. This is rather bold for a health resort. July and September of 1926 are both approximate dates of maxima rainfall, the earlier of periodicity 2·85 years, the later 2·19 years; the value of the forecast can soon be proved.

At a meeting of the Illuminating Engineering Society on April 29 a paper on "School Lighting (Modern Requirements and Recent Progress)" was read by Dr. James Kerr, who is chairman of the Joint Committee formed by the Society to inquire into this subject. Since the reports issued by this Committee in 1913, substantial progress in illuminants and lighting appliances has been made. The importance of adequate access of daylight has been emphasised by the recent recognition of the part played by ultraviolet radiation in sunlight in relation to health. For artificial lighting the Committee originally recommended a minimum of 2 foot-candles. Dr. Kerr suggested that in view of recent progress a value of 5-7 foot-candles should now be aimed at. He also emphasised the desirability of extra lighting of the blackboard, and proposed a general recommendation that sources within the direct range of vision should be toned down to 3 candles per sq. in. Dr. Kerr mentioned favourable experience with a local lamp equipped with daylight-glass so as to remove excess of red-yellow light, and he suggested that the use of suitable light-filters in schools for myopic children deserved investigation Dr. E. H. Nash (Medical Officers of Schools Association) presided. Various representatives of educational bodies took part in the discussion, in which the importance of adequate lighting, both natural and artificial, in schools was strongly emphasised.

A LECTURE given by Mr. C. E. R. Sherrington on "Rail Transport Systems of the United States" has been published in the March number of the *Journal of the Institute of Transport*. The lecture is a useful one, as it emphasises the great difference there is between rail transport in Britain and in America. With the exception of rubber and coffee the United States is practically self-supporting. Its trade is therefore mainly internal. But in order to benefit by large-scale production in steel and similar industries where overhead charges form a large fraction of the total, the surplus is exported abroad. This has the effect of cheapening transportation and tends to concentrate large-scale industries. The opening of the Panama Canal and the agricultural depression had serious effects on the Chicago to Pacific coast lines. The Chicago, Milwaukee and St. Paul Railway was forced into receivership. This was unfortunate, as this road had electrified 648 miles of its main line through the Rockies down to the Pacific coast in 1920, and to opponents of electric traction the effect produced seems to be due to this cause. In reality the traffic through the north-western States did not warrant the building of three trans-Rocky mountain lines. Electrical engineers are studying closely the working of the new Diesel electric engines. If these prove satisfactory they will serve as a deterrent to further electrification.

THE report for 1925 of the Director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington records a fruitful year's work The Department has co-operated with other American research institutions in the investigation of the conducting layer in the upper atmosphere by means of reflection of wireless waves, and the results obtained seem to be in accord with those obtained in Great Britain by Appleton and Barnett, and Smith-Rose and Barfield. In co-operation with the Carnegie Institution Geophysical Laboratory, work is being done on the effect of pressure on the critical temperature of magnetisation, the results to date are confined to nickel, using pressures up to about 2000 atmospheres, but the effects seem to be very small: the research is of interest in connexion with the depth to which permanent magnetisation of ferrous rocks in the earth's crust can exist. The reduction of the observations of atmospheric potential gradient, made on the various cruises of the *Carnegie*, has made it possible to attempt, for the first time, the construction of isoelectric charts for the greater part of the earth's surface—the oceans. Several questions of purely atomic physics, not at present obviously related to geophysics, have also been investigated under the auspices of the Department. Much observational work in terrestrial magnetism and electricity has also been accomplished, particularly at the two observatories of the Department—at Watheroo, Western Australia, and Huancayo, Peru.

THE Report of the Marlborough College Natural History Society contains its usual lists of observations in natural history, meteorology, etc. A list of about 113 fungi of the district is given by C. P. Hurst and twelve flowering plants are added to the hand-list. The permanent record of the risings of the Rockley Bourn with a graph of the last twenty-four years is due to L G. Peirson, it is a 'winterbourn' or 'hungerbourn,' a stream appearing in normally dry valleys in chalk country. Brentnall's account of the local Manor of Rockley is charming and quite suitable. A quite important and well illustrated paper on Cyclops, by A. G Lowndes, records seventeen of the thirty British species in correlation with the pH value of the water in which they lived, and describes three forms; such systematic research should be published in a regular biological journal, or it will be missed by most workers.

DR. A. DAUVILLIER, of Paris, is to deliver the seventh Mackenzie Davidson Memorial Lecture before the Röntgen Society and the Electro-Therapeutics Section of the Royal Society of Medicine on May 20 at 8.15 P.M., taking as his subject "The Measurement of X-ray Dosage." The lecture will be delivered at the Royal Society of Medicine.

AT the annual meeting of the members of the Royal Institution, held on Saturday (May 1), the following officers were elected: *President*, The Duke of Northumberland; *Treasurer*, Sir Arthur Keith; *Secretary*, Sir Robert Robertson.

THE International Association for Psychology and Techno-Psychology (*i.e.* Industrial Psychology) began its official activity on March 15. Fifteen European countries are represented in the Association, the administrative headquarters of which are at Riga, under the direction of Dr Moeller. In England the Association is represented by Prof. T. H. Pear, University of Manchester, and its department of Techno-Psychology by Dr. C. S. Myers, National Institute of Industrial Psychology. The first publication of the Association will be "A Survey of the Organisation and Position of Techno-Psychology."

We regret that by a slip in our note on the explorations in Derbyshire caves (Nature, April 24, p. 598), the name of the archæologist by whom the investigations are being carried out, was wrongly given. The work is in charge of Mr A. Leslie Armstrong.

Applications are invited for the following appointments, on or before the dates mentioned:—A professor of pure mathematics and a professor of chemistry in the Egyptian University, Cairo—The Director, Egyptian Education Office, 39 Victoria Street, S.W.1 (May 14). A public analyst for the Metropolitan Borough of Bethnal Green—The Town Clerk, Town Hall, Bethnal Green, E.2 (May 17). A head of the department of mechanical engineering and a lecturer in the department of civil engineering, architecture and building in Bradford Technical College—The Principal of the College (May 19). Junior assistants at the National Physical Laboratory with good honours degree and, if possible, research or technical experience in one of the following subjects: physics, electricity, metallurgy, engineering, aeronautics, naval architecture—The Director, National Physical Laboratory, Teddington (May 22). A professor of physics at the School of Engineering, Giza, Cairo—The Minister of Education, Cairo (May 30). An analyst in connexion with the Dairy Produce Act, 1924, in the Department of Agriculture, Irish Free State—The Secretary, Civil Service Commission, 33 St. Stephen's Green, Dublin (May 31). A bacteriologist in connexion with the Dairy Produce Act, 1924, in the Department of Agriculture, Irish Free State—The Secretary, Civil Service Commission, 33 St Stephen's Green, Dublin (June 30). A director and an assistant director of the Research Association of British Paint, Colour and Varnish Manufacturers—Mr. J. B. Graham, 8 St Martin's Place, W.C.2. A lecturer in geography and nature study at the Bedford Training College—The Principal. A resident tutor in geography at the Borough Road Training College, Isleworth—The Principal. A head of the chemistry department of the Huddersfield Technical College—The Director of Education, Education Offices, Huddersfield. A principal of the Derby Technical College—The Secretary, Education Committee, Becket Street, Derby.

Our Astronomical Column.

Investigation of Transits of Mercury.—Prof. Newcomb was the first to suggest that the unexplained fluctuations of the moon might really be fluctuations in the earth's rate of rotation. The suggestion can be tested by studying other heavenly bodies with rapid motion, notably Mercury and the inner satellites of Jupiter. Newcomb himself discussed transits of Mercury up to 1891, but failed to obtain definite confirmation of variation in the earth's rotation. *Union Observatory Circular* No. 65 contains a new investigation by R. T. A. Innes; he has repeated Newcomb's work, correcting a few minor errors, and has included the four recent transits of 1894, 1907, 1914, 1924, all well observed. The semi-diameters deduced for the sun and Mercury at unit distance are 959″·48 (0″·15 less than that of Auwers) and 3″·08. The latter is undoubtedly less than the real semi-diameter of Mercury, owing to irradiation.

A diagram is given of the time-residuals of the transits from 1677 to 1924; they are compared with Newcomb's diagram for the moon, and there is a certain similarity between them. Both have maxima near 1680 and 1885, and a minimum about 1780, the curve for Mercury between these limits is much more undulating than the lunar one. Jupiter's satellites I, II, are also used for the last thirteen years, and accord well with the Mercury curve in showing a rapid downward movement.

There is therefore a fair case for ascribing the errors in position of the different bodies to a common cause, namely, changes in the earth's speed of rotation. Dr. Innes seems to be in error in one point. He mentions the error of the equinox as due to a similar cause. But a shift of the sun along the ecliptic does not affect the position of the intersection of ecliptic and equator.

Masses of Stars of Types F to K.—*Astr. Nach.* No. 5434 contains an article on this subject by B. P. Gerasimovic. He points out how few stellar masses are accurately known, and how useful it would be to find a general method of obtaining them in the case of stars without visible companions. Two methods have been suggested; first, that of the equipartition of energy, which if established would correlate mass with velocity, secondly, Pannekoek's method from comparison of trigonometrical parallaxes with spectroscopic ones. The latter method is complicated by the effect of radiation pressure in diminishing gravitation, especially in the hottest stars.

The author bases his work on the Victoria parallaxes, and the masses of binaries with well-developed orbits. The equipartition principle is first tested; the quantity (mass) × (velocity)^2 is formed for a large number of stars of types F, G, K. The mean values of the product for the three types are 3·47, 3·45, 3·59, in good agreement with Seares's value 3·57 obtained in quite a different manner. It is concluded that both the equipartition theory and Pannekoek's principle are sound, and can be applied statistically, though there may be large deviations for individual stars.

Prof Eddington's proposition of correlation of mass with absolute magnitude is then tested, graphs being drawn for the different types. They show large departures from linearity, there being evidence of discontinuity between M = 2·0 and M = 3·5, about the region of demarcation between giants and dwarfs.

The paper concludes with a list of deduced masses and densities of 74 stars with parallax 0·07″ or greater. The five largest masses are 61 Ursae Maj. 4·1, δ Eridani 3·7, 61^2 Cygni 3·5, η and γ Cephei each 3·0. 61^2 Cygni is given the great density 31·8, that of Arcturus is only 0·0005, its mass being 1·6. These data are only provisional, but they give hope of future increase of knowledge in this very important but difficult field.

Research Items.

CAPSIAN AFFINITIES OF THE LATER STONE AGE CULTURE OF SOUTH AFRICA.—The possibility of connexion between the Stone Age cultures of North and South Africa was discussed with some precision by Mr. A. J. H. Goodwin of the Cape University, in a paper presented to the South African Association for the Advancement of Science in 1925 and now published in vol. 22 of the *South African Journal of Science*. Of the three industries forming the later Stone Age in South Africa, one is the pygmy industry, a second has been named the Smithfield industry. The characteristics of the pygmy culture are scrapers, points, the geometrical pygmy implements, ostrich shell beads, bone implements, paintings on walls or stones, possibly stone palettes, and the habit of eating snails. The Smithfield industry includes duck-bill scrapers, of a type larger than the pygmy, and shading to the circular scraper, blades and tanged points. In North Africa in the late Capsian is found a culture with end-scrapers, blades, points, tanged arrow-heads, crescents, ostrich egg-shell beads, and bone awls exactly similar to those of the pygmy and Smithfield cultures of South Africa. There is also the possibility that the North African Capsian may be connected with paintings. It is concluded, therefore, that the later Stone Age of South Africa is an offshoot from the Capsian culture.

MENDELIAN HEREDITY AND RACIAL DIFFERENCES.—Prof. R. Ruggles Gates points out in a communication appearing in vol. 55, Pt. 2, of the *Journal of the Royal Anthropological Institute*, that although innumerable peculiarities and abnormalities are found to be inherited in man as simple Mendelian differences dominant or recessive to the normal or sex-linked in various ways, anthropologists have not yet generally recognised the wide spread of Mendelian inheritance in man. Data relating to such characters as eye colour, stature, and cephalic index, however, are rapidly accumulating. The known facts do not justify the distinction sometimes made that Mendelian inheritance applies only to abnormalities, and that racial differences follow other rules and do not segregate. Eye colour was the first character in man to be recognised as Mendelian in its inheritance. It is well known that it segregates in families. Segregation also occurs in inter-racial crosses. There is nothing at present to indicate that its inheritance in such crosses differs from that within a single race. As regards stature, while it is characteristic in many races, it is clearly not a unitary thing but the result of many diverse elements acting under a particular set of environmental conditions. In the case of the cephalic index it is clear that brachycephaly and dolichocephaly are not determined by a simple Mendelian pair of factors. The work of Fritz, Hildén, and others indicates that the cephalic index may be determined by several cumulative polymeric factors, *i.e.* genetic factors, each of which produces a certain transition from dolichocephaly towards brachycephaly. It appears that such "racial" characters as stature and cephalic index do not differ in their hereditary behaviour from size and shape differences generally, and have no special virtues as being "racial" distinctions. But there is great and urgent need for accurate observations on the results of inter-racial crosses in mankind.

EFFECTS OF THYROID ADMINISTRATION.—Prof. Ercole Giacomini gives an account in the *Rendiconto della R. Accademia delle Scienze dell' Istituto di Bologna* of the interesting results observed on the administration to fowls of thyroid, which produces marked changes in their metabolism and influences more particularly the development, appearance, and colour of the plumage. Ingestion of fresh ox thyroid by young or old fowls of either sex infallibly determines a pronounced stimulus to the production of feathers. In some cases the old feathers are made to fall in a manner so rapidly that in a few days the body may become almost bare, being covered only by the germs of the new feathers, which are surrounded by horny sheaths and resemble short prickles. Moreover, with birds having coloured feathers there takes place an alteration in colour, usually a depigmentation, the extent and intensity of which are enhanced if administration of the thyroid is continued. In certain instances, however, but never with white fowls, the opposite phenomenon occurs, increased formation of black pigment being observed in the feathers on some parts of the body. Similar but less pronounced changes follow the use of dried thyroid.

GENETICS OF LOCUSTS.—Continuing his genetic experiments with grasshoppers, Nabours (*Kansas Agric. Sta.* Bull. 17) has published the data from twelve years' breeding of the grouse locust, *Apotettix eurycephalus*. Eleven different colour patterns of this locust, all found wild, have been bred with the 'normal,' to which they are all more or less dominant, and with each other. More than 134,000 individuals were examined in the experiments, and the patterns of a large number of specimens are permanently preserved in alcohol. By means of the crossing-over data and other hereditary behaviour, all these factors are mapped as belonging in a single linkage group (or chromosome), and nine of them form three groups of multiple allelomorphs containing respectively three, four and two factors. With certain factors, the percentages of coupling and repulsion obtained were quite different. These and certain other inconsistencies are attributed to the highly variable conditions under which the experiments were conducted. Very interesting phenomena of parthenogenesis were obtained in some of the females.

AGE AND GROWTH OF HADDOCK AND WHITING IN ICELANDIC WATERS.—Bjarne Saemundsson writing in *Meddelelser fra Kommissionen for Havundersøgelser, Serie : Fiskeri*, Bind viii, Nr. 1, 1925, states that the haddock has long been one of the favourite food-fishes of the Icelanders. It has also been cured (split and salted) on a large scale for export, being formerly second only in importance to the cod, although it now occupies third place as an article of export, having given place to the herring. From his study of the scales, Saemundsson concludes that the growth of the Icelandic haddock follows a similar rule to that of the cod : "It is most rapid on the south and the west coast, and gradually decreases as we turn to the right round the country, being slowest on the east coast." This decline in growth is attributed to the fall of temperature in the said direction, an influence which also prevents the spawning of cod, haddock, and many other fishes. In comparison with other regions, the rate of growth of the Icelandic haddock is only surpassed by that of the Faeroese ; while the size attained is also very large compared with that in more southern waters, so that ages 9-14 years commonly occur. As with the cod, there is a noticeable difference in the size of the sexes, the males being the inferior in size for corresponding age. Sexual maturity is first reached when the fish (both sexes) is four years old and about 47 cm. long. It is significant that the majority of haddock caught in Icelandic waters, particularly in shallow inshore areas, are young immature fish, but the 5-yearly means of the catches from 1897 to 1919 do not indicate that there has been any decrease in stock as the result. Unlike the haddock, the whiting gives rise to no special or important fishery. This fish is also able to grow to a much larger size in Icelandic waters than in neighbouring seas, and, as with the cod, the female is larger than the male, and probably reaches a higher age. A common feature of the scales of whiting is the presence of a considerable number of narrow rings within the first summer-zone. These narrow rings are only separated from the centre by two or three broad summer-rings, and although they assume the appearance of a normal winter-zone, their position seems to render this interpretation untenable. Saemundsson suggests that this false ring may be looked upon as a consequence of some change in the life of the fish, *e g.* moving from shallow to deeper (cooler) water, or the transition from pelagic to bottom life.

Chromosomes of Hyacinth.—The chromosomes of the hyacinth and two related genera have been studied by Mr. C. D. Darlington (*Journ. Genetics*, vol. 16, No. 2), *Hyacinthus orientalis* and *Scilla nutans* having 8 chromosomes, while *Bellevallia romana* has 4. But Hyacinthus is not strictly tetraploid, because one of the four long chromosomes has a constriction which is not found in the other three chromosomes. In Scilla the chromosome sizes and constrictions are different from those of the hyacinth, and neither condition is directly derivable from the diploid Bellevallia, owing to differences in the constrictions and sizes of the chromosomes It is concluded that the constriction is not necessarily at the point of application of the force which moves the chromosome, and that the centre of attraction of the chromosome is not strictly localised. The latter conclusion is contrary to some previous evidence.

New Technique with Fossil Plants.—Mr. T M. Harris describes in the *New Phytologist* (vol. 25, No. 1, 1926) a new method for examining plant remains in shale, by which the whole of the more resistant plant material is rendered available, and not merely plant impressions exposed on split surfaces. The shale is first immersed for some days in strong nitric acid containing about 5 per cent. potassium chlorate; after washing in running water it is then placed in dilute sodium hydroxide, in which it breaks down into a fine mud from which resistant fragments of cuticle, and sometimes of other tissues, can be strained off by wire gauze. These fragments are finally cleaned in 25 per cent hydrofluoric acid. A great number of leaf fragments, small seeds, bird scales, etc., were thus obtained, together with two characteristic megaspores of *Lycostrobus Scotti* Nath., of which only one other specimen is known. From a piece of shale consisting mainly of *Sagenopteris Nilssoniana* (Brongn) Ward., pollen grains, anthers, and seeds were obtained which were scarcely distinguishable from those described by Dr. H. Hamshaw Thomas for the Caytoniales. As these organs were not found in other shales, this strengthens the evidence for Dr. Thomas' view that the leaves of the Caytoniales were of the Sagenopteris type. By this method Mr. Harris has been able to study about one-half of the total number of species (106) now known of the early Mesozoic flora from the Rhaetic bed of East Greenland.

Determination of the Salinity of Sea Water.—Prof. Giral discusses in "Quelques Observations sur l'emploi de l'eau normale en Oceanographie" (*Publication de Circonstance No. 90*, International Council for the Exploration of the Sea, Copenhagen) the source of error in calculating the total salts content or salinity of sea water from the chloride content as determined by titration. Although the salts occurring in sea water are present in almost the same proportions in the open oceans, slight variations are known to occur which renders the calculation 'conventional.' The various errors occurring in the usual titrimetric determination of salinity are considered, from which Prof. Giral concludes that these prevent an approximation closer than the first decimal place per kilogram of sea water in all determinations of chlorides and salinity.

Long-range Forecasting.—Sir Gilbert Walker gives a summary in the *Meteorological Magazine* for March of some recent papers by W. Wiese. It is mentioned that there has of late been considerable meteorological activity in Russia, and amongst this is the work of Wiese upon conditions in the North Atlantic considered in the light that it may throw on English weather. Associated with years of much ice in the Barents Sea, there is in advance a south-eastward displacement of the axis of the trough of low pressure off the west coast of Norway. An attempt is made to associate ice in the polar seas and the general circulation of the atmosphere extending the connexion between the Arctic and Antarctic, but it is pointed out that this appears to be unproven. There seems to be a close relationship between Barents ice and air temperature in Europe The influence of the mean air temperature in spring in N Iceland on the mean air temperature of the following winter in Europe is dealt with. Other meteorological correlations are referred to. In summing up Wiese's work, Sir Gilbert remarks that while conditions in the Barents Sea do not exercise a profound influence on the conditions of the Southern hemisphere, they are of importance in a fairly wide region of the northern hemisphere.

Gold in the Dartmoor Granite.—In the *Mineralogical Magazine* for March, Dr. A. Brammall describes his investigation of the modes of occurrence of gold on Dartmoor. Detrital gold was first identified in samples of stream-sand and 'head.' A gold-bearing pegmatite on Bittleford Down was then found, and described in collaboration with Dr. H. F. Harwood. Since then gold and silver have been detected in the normal grey biotite-granite at various localities on the Moor. The gold is found as inclusions, sometimes visible, in both quartz and felspar, and together with silver in biotite. The evidence is conclusive that the two metals are primary products of crystallisation from the granitic magma. Careful examination of vein-quartz, and assays of pyrites and of pneumatolysed rock showed that the gold-silver content of the granite cannot be attributed to either pneumatolytic or hydrothermal processes. Similarly occurring primary gold has already been recorded from granites in California and Nevada.

Kames and Drumlins in Scotland.—Prof. J. W. Gregory defines 'kames' as ridges of fluvioglacial or glacieluvial sand and gravel, deposited along the margin of a glacier during some halt in its retreat, where the ice front was bounded by water (*Trans. Roy Soc. Edin*; vol. 54, pt. 2, No 7, 1926). As a result of an extensive study of the distribution and structure of the Scottish kames he concludes that they have all the characteristics of marginal formations, like the majority of Irish eskers, and that they give no support to the view that they were formed along the course of sub-glacial rivers. The term 'kame' has been applied to various formations in Scotland, including moraines, denudation mounds, and even rounded hills of slate. After eliminating these, the typical true kames that remain number only a score, nearly all of them being in the east near the foot of the Highlands. On the west the glacial deposits were laid down as moraines rapidly dumped from melting ice. In a further paper (*Ibid.* No 8) Prof. Gregory discusses the origin of 'drumlins.' He argues that the trend of the Scottish drumlins shows that they have been moulded mainly by sub-aerial erosion guided by the wind.

ISOSTASY IN NORWAY.—An important paper by W. Heiskanen on the reduction of gravity observations in Fennoscandia has been published as No. 5 of the *Veröffentlichungen des Finnischen Geodätischen Institutes*, 1926. It is shown that in southern Norway the adoption of the Pratt-Hayford hypothesis of isostasy points to a depth of compensation at 80 km., while the Airy hypothesis leads to the deduction of an outer crust having a thickness averaging 37 km. Which of the two rival views is more in accord with the actual results is difficult to determine, but the author favours the Airy hypothesis as being equally well supported by the residual anomalies, and more in accordance with geological and geophysical probabilities. Reference is made to Gutenberg's estimates of the thickness of the earth's crust: under Eurasia (55-60 km.), America (*ca.* 50 km.), the Atlantic (*ca.* 25 km.) and the Pacific (0-5 km.), and these are compared with other determinations based on the Airy hypothesis: in the Alps (41 km.), North America (50-60 km.), and the Caucasus (77-104 km.). The Airy hypothesis thus appears to receive a certain amount of direct support, but it must be admitted that the apparent concordance of some of the figures means very little. Stoneley and Jeffreys have recently pointed out a fundamental source of error in Gutenberg's work, due to the effects of dispersion of seismic waves having been overlooked. The necessary correction reduces the thickness of the continental *sial* layer to about 15 km This does not, however, invalidate the Airy hypothesis, for the depth of compension need not be identical with that of the *sial* layer. It is interesting and significant that in Europe opinion is steadily veering away from the somewhat artificial Pratt hypothesis followed by Hayford and still adopted in the official American work on isostasy.

COLOUR OF THE ALKALI METALS.—In a short paper communicated to the Vienna Academy of Sciences on February 4, 1926, Prof. Przibram gives an account of the "Interpretation of colour changes in salts." He detects a progressive change in the direction of longer wave-lengths of the absorption produced by atoms of metal in the lattice of a salt at low temperatures, at high temperatures, with a distorted lattice (*e g.* the colour produced by exposure to radium of salt which has been fused with a small percentage of boric acid), in glass, in colloidal coloured crystals, colloidal solutions, and finally in the vapour. These colour-changes are attributed to a progressive relaxation of the forces which are imposed on the atoms of the metal by the lattice of a salt-crystal; for example, a crystal of rock-salt which is coloured yellow by the presence of traces of the free metal.

ESTIMATION OF ANTI-TETANIC SERUM.—In the 1923–1924 volume of the *Rendiconto della R Accademia delle Scienze dell' Istituto di Bologna*, Prof. Plinio Bardelli gives the results of a series of experiments showing that the antagonistic behaviour of anti-tetanus serum towards strychnine is determined by the same anti-body as neutralises the tetanus poison. It is therefore suggested that strychnine be used as a means of evaluating anti-tetanic serum. It is true that, in so far as chemical constitution is concerned, there is a wide difference between strychnine and the tetanus toxin, but the effects resulting from the administration of strychnine follow the same course as tetanus, whereas this is not the case with the arbitrary antigen used in the diagnosis of syphilis. Further, the use of strychnine obviates the serious difficulties contingent on the qualitative and quantitative differences of the toxins derived from different strains of the tetanus organism.

AIR/GAS RATIO IN GAS BURNERS.—The subject of the aeration of upright and inverted lighting burners is discussed in the thirteenth Report of the Gas Investigation Committee of the Institution of Gas Engineers. A rapid increase in the degree of aeration accompanies an increase of the gas supply pressure up to 2·5 in. of water, above which any further increase of aeration is relatively small. The amount of air injected as primary air, when the burners are in normal operation, is slightly less than half that required for complete combustion of the gas The air to gas ratio of the mixture produced by the injection is higher for the upright than for the inverted burner, the burners being adjusted for best illumination. This air/gas ratio is materially reduced as the burner becomes heated, but is not appreciably altered by the use of a chimney. The differential-pressure column method of the Fuel Research Board (Technical Paper No. 5) for the determination of the specific gravity of gases is shown to be accurate to within 0·002 when applied to the ordinary grade of towns' gas supply (specific gravity about 0·5). The fourteenth Report is devoted to a description of an experimental carbonisation plant, comprising settings of two horizontal retorts and two vertical retorts, and the usual condensing and purifying plant, erected at the University of Leeds as a memorial to Sir Corbett Woodall.

HIGH TEMPERATURE STANDARDS.—The issue of part 4 of the *Abstract Bulletin of the Nela Research Laboratory* completes vol. 1 of the Bulletin Part 4 contains Abstracts 99 to 138 on pp. 523-737 of the volume. The researches to which they refer were carried out under the late Dr. E. F. Nichols, of whom a portrait is given. Many of the abstracts cover papers which have appeared at various times in the scientific and technical press and sum them up in a compact form. Thus abstract No. 108 condenses into 14 pages the results published by the Nela Laboratory in seven different periodicals during the past seven years on the subject of optical pyrometry. One of the most important abstracts deals with an intercomparison of high temperature scales in use at the Nela Laboratory, the Bureau of Standards, the National Physical Laboratory, the University of Wisconsin, and the General Electric Company's Research Laboratory. The temperatures of the filaments of seven incandescent electric lamps run at stated currents were measured at each laboratory and the results compared. Three of the laboratories take the melting-point of gold, 1336°, on the Kelvin scale as the standard temperature, while two others take the melting-point of palladium, 1828° K and 1822° K respectively. The temperatures estimated by the latter laboratory are all 10° to 20° higher at about 2000° K than those of other laboratories, which agree with each other to within 10° at 2700° K.

Application of Subatomic Thermodynamics to Astrophysics.

THE presidential address to the Mathematics and Physics Section of the thirteenth Indian Science Congress held at Bombay on January 4, by Prof. M. N. Saha, contains a résumé of the work of the last few years on the physical interpretation of stellar spectra. We are unable to find space to reproduce the whole address, but the following summary and extracts include some of the main subjects surveyed.

Since the foundations of astrophysics were laid by Kirchhoff in 1859, the spectroscopic survey of the heavens has been carried on with great vigour by many workers, and the spectra of more than 200,000 stars have been classified at the Harvard College Observatory. In the interpretation of the spectra, however, two difficulties have arisen. First, there are several elements, common on the earth, which are not represented in the spectra of the stars; secondly, the elements represented in the stars are not all the same, but vary from one star to another in such a way that a continuous sequence of spectra can be arranged corresponding to a sequence of colour from blue-white through yellow to red. The character of the spectral change along the sequence is that in going from blue to red stars the spectral lines indicate a gradually decreasing excitation stimulus.

Lockyer long ago explained the phenomena by supposing that a spectrum was an indication of temperature, and that in the high temperature blue stars the elements were dissociated into simpler forms. This hypothesis offered a sufficient explanation of the facts, but was unwelcome on account of its revolutionary character. In recent years, however, this criticism has ceased to hold good, and in Prof. Saha's address an "attempt has been made to show how modern discoveries have led us to a complete justification of the main ideas of Lockyer."

When a gas is raised to a high temperature, the violence of the atomic collisions is conceived to result in the detachment of electrons from atoms. At any temperature a state of statistical equilibrium is reached, in which the rate of ionisation is equal to the rate of recombination. The gas then consists of ionised atoms, neutral atoms, and electrons, and at each recombination of an electron with an ionised atom, radiation is emitted. The fraction (x) of dissociation can be calculated in terms of temperature (T) and pressure (P), and is found to be given by the equation:

$$\log \frac{x^2}{1-x^2} \cdot P = -\frac{U}{2 \cdot 3RT} + \frac{5}{2}\log T - 6 \cdot 5 = K,$$

where U is the ionisation potential of the atom and R is the gas constant. The formula, as Russell has shown, needs modification when more than one element is present—a statement confirmed by both experiment and observation—and, further, represents only an approximation to the complexity of an actual case, since the various excited states of the atom have not been distinguished, but it is sufficiently exact to explain the main details of the spectral sequence.

From the observed positions in the sequence at which particular lines appear or disappear (which we may take to indicate the conditions under which the appropriate atoms begin or cease to be capable of emitting the respective lines), the above equation, combined with spectral data, gives a relation between the temperature and pressure in the stellar atmosphere. Assuming a likely value for the latter, the temperature can be estimated, and is found to agree fairly well with the photospheric temperatures measured by direct experiment. This constitutes a justification for the view that ionisation in stellar atmospheres is a function of temperature and pressure. It has long been an unsettled question whether temperature alone can stimulate radiation, but recent experimental evidence indicates very definitely that it can do so. The theory under consideration not only provides for this, but also shows that the failure of earlier experiments was due to the choice of elements having high ionisation potentials, which, according to the equation, require high temperatures for ionisation or excitation. The implication that the degree of ionisation is increased by lowering the pressure is also borne out by experiment. The theory further explains the apparent absence of certain elements from the sun and stars by the argument that their chief spectrum lines under the conditions existing in the atmospheres are outside the range of observation.

Prof. Saha, to whom the theory in the above form is due, points to further evidence of thermal ionisation in the fact that the electrical conductivity of heated gases depends on their ionisation potentials. This at once follows from the theory if the conductivity is due to the presence of free electrons, for it must then be dependent on the percentage of ionisation, which is a function of the ionisation potential.

Later developments of the theory are mainly indebted to applications of subatomic thermodynamics to the problem. Following the lines of Ehrenfest's re-examination of Planck's thermodynamics, Fowler and Milne, Becker, Saha and Sur, have been the chief workers in this field.

"The scope of Fowler and Milne's work will be realised from the following brief summary: As mentioned above, when an original mass of calcium is heated, the products of decomposition are not only ionised calcium atoms and electrons, but also calcium atoms in the excited states, which, being unstable, give rise to the line spectrum of calcium. As the spectrum of calcium is rather complicated we shall take a simpler case, namely, hydrogen. The products of decomposition are then H⁺, electrons, H-atoms in 2_1, 2_2, 3_1, 3_2 . . . states, radiation $\nu = R\left(\frac{1}{1^2} - \frac{1}{n^2}\right)$ constituting the Lyman series, the lines $\nu = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$, constituting the Balmer Series, etc. . . . In the simple theory sketched above, we neglected these intermediate orbits on the ground that even at the highest temperatures, their proportion calculated according to Maxwell's theorem is small.

By applying Ehrenfest's method (which has been improved on mathematical points), Fowler obtains the equation:

$$\log \frac{x^2}{1-x^2} P = K - \log b(T)$$

in place of the original equation. The function $b(T)$ represents the occurrence of the intermediate orbits

$$b(T) = g_1 + g_2 e^{-\frac{U_2}{kT}} + \ldots g_n e^{-\frac{U_n}{kT}} + \ldots$$

where g_n is the intrinsic weight of the nth intermediate orbit, U_n its energy. According to Bohr $U_n = R\left(1 - \frac{1}{n^2}\right)h$, ($R$ = Rydberg number), and $g_n = n(n+1)$ (according to Herzfeld and Epstein).

It may be mentioned here that $b(T)$ is divergent, and in order to get over this difficulty, Fowler thinks that $b(T)$ ought to be limited to a finite number of terms. He argues that as the nth orbit has a radius of a_0n^2, the series cannot be developed when the distance between two atoms is of this order, for the electron then passes into no-man's-land. As was pointed out in a note to NATURE, there is strong experimental evidence for believing that the development of higher orbits depends upon pressure (one has to think of Wood's method of getting higher lines of the Balmer series), and this is also supported by astrophysical data (see Miss C. Payne's "Stellar Atmospheres," page 48). Urey has recently shown that $b(T)$ becomes convergent when the finite volume of molecules is taken into account.

But the weak point in the argument is the assumption $g_n = n(n+1)$, and it seems to be unsound on physical grounds.

The conclusions which Fowler, and Fowler and Milne (*Month. Not. R.A.S*, vol 83, page 403) have drawn are, however, largely independent of the form of $b(T)$, and are of the greatest importance. It will be recalled that many elements, for example, mercury, have to be detected by subordinate lines, while others like calcium can be detected by principal, as well as subordinate lines Fowler and Milne discovered a very remarkable difference between the behaviour of the principal and subordinate lines in stellar sequence. They found that while principal lines are most intense at the lowest temperatures, and gradually weaken in the higher classes, the subordinate lines are at first faint, then increase in intensity, reach a maximum, and then die out The explanation is as follows: At the lowest temperature, all atoms are in the lowest state. Subordinate terms come out only at higher temperatures. But when the temperature is very high, the atom begins to get ionised, and hence the proportion of atoms in the subordinate states begins to fall off A maximum must have been reached in the interval

When the above ideas are translated into mathematical language, and conditions for maximum concentration of subordinate levels applied, we get a relation connecting the electron pressure and the temperature in the reversing layer. In fact

$$P_e = \frac{0\ 332}{b(T)} \cdot \frac{U_r + \frac{5}{2}RT}{U_1 - U_r} T^{5/2} e^{-\frac{U_1}{kT}} . \quad . \quad . \quad (1)$$

For example, the Balmer-lines of hydrogen arise from the 2-orbit, and they reach their maximum in the A-class. The temperature of these stars lies between 10,000° K to 12,000° K Substituting these values in (1), we obtain $P_e = 1{\cdot}31 \times 10^{-4}$ to $3\ 07 \times 10^{-4}$ atmospheres.

Fowler and Milne have thus found a very elegant method of determining the pressure. This is in itself a result of the first magnitude, for ionisation depends very largely on pressure, and after Einstein's discovery of the shift of lines towards the red by gravitational potential, the older values which were based on pressure-shift of lines have been rendered obsolete

Values of P_e have been calculated from considerations of the maxima of several elements, and they invariably give a range of pressure varying from 10^{-3} to 10^{-5} atmospheres These values recall the statement of Jewell; 'The whole mass in the reversing layer of the sun can be contained in a thimble' . . .

Prof. Milne has recently given an entirely new method of dealing with thermal ionisation of gases. In contradistinction to the thermodynamical method hitherto used, this method may be called the kinetic method. These two methods find their parallel even in the study of chemical equilibria. Let us represent a typical homogeneous equilibrium by the equation

$$mA + nB \rightleftarrows pC + qD.$$

Then according to the thermodynamical method we put

$$mS_A + nS_B - pS_C - qS_D = \frac{U}{T},$$

where S's are the entropies, and U is the heat of reaction.

In the kinetic method, the rate of change from left to right depends on the number of times m molecules of A come into contact with n molecules of B. The velocity of reaction $V_{AB} = K_1 C_A C_B$, and $V_{CD} = K_2 C_C C_D$. In the equilibrium case

$$V_{AB} = V_{CD}, \text{ hence } \frac{C_A C_B}{C_C C_D} = \frac{K_2}{K_1} = \text{constant}.$$

By using this method, Boltzmann gave a formula for molecular dissociation, which has the same form as that derived from thermodynamics.

Thermal ionisation of gases is only a particular form of chemical dissociation with the difference that the details of the mechanism are much better understood in the former case. Hence it is expected that the kinetic method would be very fruitful here.

Every kinetic method depends upon a closer treatment of the mechanism of reaction. The reaction in the present case is decomposition of M into M^+ and e (electron), and this can take place in various ways. To any one of these processes there is an opposite process resulting in recombination of M^+ and e to M. A pair of such oppositely directed processes has been called by R. H. Fowler 'a unit mechanism.' Each one of these unit mechanisms, by itself and without the aid of any other process, would give us some fundamental laws of general validity. This is known as the 'principle of detailed balancing.'

The ionisation of M-atoms placed in a thermal enclosure can occur:

(*a*) As a result of collision of two H atoms; the rate of ionisation is then proportional to the square of pressure.

(*b*) As a result of absorption of radiation by H atoms, normal as well as excited.

Thus, according to Bohr's theory, radiation of frequency higher than $\nu = \frac{R}{1^2}$, when falling on the normal hydrogen atom, would completely ionise it If the electron is in the 2-state, radiation shorter than $\nu = \frac{R}{2^2}$ would ionise the atom. Such a process of ionisation may be called photoelectric ionisation. This is true of every element, and in the case of alkalies it has been definitely proved that their vapours are ionised by radiation shorter than that corresponding to the limit of the principal series.

The reverse processes are:

(*a'*) Process (*a*), ionisation by collision is radiationless. The reverse process of capture when M^+ and e come together must also be radiation-less Hence when M^+ and e combine together, the energy set free must be carried away by a third body. Hence the reverse process to (*a*) is a three body encounter between M^+, e, and M (or e), the energy liberated being carried off by M. The unit mechanism (*a*), (*a'*) has been studied by R. H. Fowler in an extension of the ideas of Klein and Rosseland on the so-called collisions of the second type.

(*b'*), the reverse process to (*b*), must naturally be the capture of an electron by the ion M^+, with liberation of radiant energy. But Milne finds that (*b*) and (*b'*) together do not give the law of reaction isochore. So he postulates that electrons may be captured even under the influence of radiation. This last process is analogous to Einstein's 'Negative Einstrahlung' or stimulated emission. Thus we may write—

> Rate of photoelectric ionisation = Rate of capture with emission + Rate of capture under the influence of radiation.

Compare this with Einstein's well-known method of deducing the law of black body radiation:

> Rate of absorption of light = Rate of spontaneous emission + Rate of emission under the influence of radiation.

With the aid of certain assumptions, Milne calculates the rates of free and stimulated captures and equates it to the number of photoelectric ejections. The equation may be used in two ways. It may be employed to evaluate the degree of ionisation, in which case some further assumptions are necessary. Conversely, assuming the thermodynamic formula for ionisation, it can be used for finding out the law of probability of electron capture. In this way Milne arrives at the conclusion previously reached by Eddington in his study of opacity of stars, namely, that the electron is captured only when it actually hits the nucleus. Probably a more rational way of expressing the result would be: Only one in 10^8 collisions results in a capture.

Applied to hydrogen, calcium, and mercury, Milne's method furnishes values of absorption coefficients which are in general agreement with experimental values.

It is yet too early to predict how far Milne's method in its present form will be able to advance the theory of thermal ionisation. The great difficulty which is encountered in the development of these methods is due to the absence of any suitable quantum theory of absorption of lines. The present theories are a sort of half-hearted compromise with the old Lorentz theory which ascribes absorption to damping produced by collision."

The Sea-Urchins of New Zealand.

By H. FARQUHAR, Wellington, N.Z.

THE following notes were written some time since, but were held back until Dr. Mortensen had published his zoogeographical notes on New Zealand echinoderms (*Vidensk. Medd.*, Bd. 79, 1925). They are now given here because the subject is approached from a different point of view; namely, that of the New Zealand biological region; and also because I find myself obliged to differ from him on some points. For example, Dr. Mortensen believes that Wegener's hypothesis of continental displacement "gets support also from the study of the New Zealand Echinoderm fauna"; while I am of the opinion that the evidence of our fauna and flora at large, including the littoral, is strongly against Wegener's hypothesis as regards Australia and New Zealand; and that it mainly agrees with the evidence of the micro-Lepidoptera as stated by Mr. E. Meyrick in NATURE of May 30, 1925. The more I have learnt of the New Zealand fauna and flora in general, and particularly of several small groups, the more I have been impressed by the great fundamental differences between the faunas and floras of the two regions; and, as Meyrick says, "The amount of community shown here is then no greater than might be expected if the conditions had always been as at present," etc. When we remember, moreover, that the New Zealand land-area was greatly elevated and extended far to the north-west in early Tertiary times, and, again, to a less extent perhaps, later, we may well be surprised that the affinities are not much stronger.

Reasons for the recognition of the New Zealand area as a primary zoological region were set forth in NATURE of January 11, 1900. Objections by Mr. Wallace were given in the issue of January 18, and support by Prof. Alfred Newton and Mr. Hedley in the issue of January 25, and April 19, respectively. In a letter to me, at that time, Prof. Newton wrote, "I have no doubt that the littoral marine fauna has also an exceedingly interesting story to tell"; and as the several groups of the littoral come to be worked and revised the more distinctly and clearly does this "interesting story" become known. In the preface to his "Manual of N.Z. Mollusca," 1880, that keen and indefatigable observer, the late Capt. Hutton, said, "The better the fauna of New Zealand becomes known, the more prominently does it stand out distinct from that of any other country"; and this is now being verified by all New Zealand naturalists. What makes the history of our plants and animals especially interesting and important is that this area is a *biological* region of primary rank (Holloway, *Trans. N.Z. Inst.*, vol. 55, p. 67; Cockayne, "New Zealand Plants and their Story," etc.), for here and here only the botanical region is coterminous or almost coterminous with the zoological region; and the evidence of the botany, zoology, geology, palæontology, the physical conditions of the land, and the form of the sea-bed all harmoniously contribute to the wonderful past history and present status and character of this remarkable region.

Of course the littoral marine fauna does not speak so clearly and forcibly as the land fauna, for species of some of the groups (hydroid zoophytes, mollusks, echinoderms, etc.) have recently been widely spread by oceanic currents, but the evidence, in the main, agrees with that of the terrestrial plants and animals.

The New Zealand sea-urchins have been recently revised and the number of known forms increased by Dr. Mortensen of the Copenhagen Museum (*Vidensk. Medd.*, Bd. 73, 1921); and Dr. H. L. Clark of the Museum of Comparative Zoology has given an excellent classification of the group, based upon all the light of recent research, in his "Catalogue of the Recent Sea-urchins in the British Museum," 1925. The littoral forms are those which inhabit the area lying between high-water mark and the hundred-fathom line (the continental shelf). Large portions of this zone are entirely unknown, and many more species will by-and-by be added to our list, which at present consists of 22 forms:

1 *Goniocidaris umbraculum*, Hutton
2 *Austrocidaris benhami* (Mortensen)
3 *Cidaris sp.* (Young), Mortensen
4 *Araeosoma thetidis* (H. L. Clark)
5. *Amblypneustes ovum var pachistus*, H. L. Clark
6. *Holopneustes inflatus*, A. Agassiz
7. *Pseudechinus albocinctus* (Hutton)
8. *Pseudechinus novaezealandiae* (Mortensen)
9. *Pseudechinus huttoni*, Benham.
10. *Pseudechinus variegatus*, Mortensen.
11. *Pseudechinus grossularius* (Studer)
12 *Evechinus chloroticus* (Valenciennes)
13 *Heliocidaris tuberculata* (Lamarck)
14 *Clypeaster virescens*, Doderlein
15 *Arachnoides zelandiae*, Gray
16 *Peronella hinemoae*, Mortensen.
17 *Laganum depressum*, Agassiz?
18 *Echinocyamus polyporus*, Mortensen.
19 *Apatopygus recens* (Milne-Edwards).
20 *Brissopsis zealandiae*, Mortensen?
21. *Spatangus multispinus*, Mortensen
22. *Echinocardium cordatum* (Pennant)

The three known species of the first order of Echini (Cidaroida) appear to be endemic. *Goniocidaris umbraculum* is nearly related to the two Australian forms, *geranioides* and its variety *Kubaria*, of this small, southern, littoral genus, as now restricted. The three species belong to closely allied genera of a widespread, very ancient group, the Cidaridæ. The young Cidaris described by Dr. Mortensen may be the young of a known form, but is more likely that of an undescribed species

Of the second order (Diadematoida) there are ten known forms. The first of these, *Aræosoma thetidis*, which occurs also off the south-eastern coast of Australia, is a species of a prosperous, widespread genus, the home of which is in deeper water. The specimens were obtained from 70 fathoms, and it is evidently a migrant from the continental slope. The two forms *Amblypneustes ovum* var. *pachista* and *Holopneustes inflatus* belong to a very interesting but difficult group (the Temnopleuridæ). These two genera are wide-ranging and closely related; and both species occur freely on the eastern and southern coasts of Australia; and have doubtless come thence. The next group consists of five endemic species of the essentially New Zealand genus Pseudechinus. Only one other species is known (*P. magellanicus*) from the southern coasts of South America, the Crozet and Marion Islands. It is closely related to *P. albocinctus*; and it has no doubt drifted from New Zealand. All its stations are in the area of distribution of the seaweed *Macrocystis pyrifera*. Hawkins has noted that two species, *P. albocinctus* and *P. novæzealandiæ*, have been found in raised beaches of probably Pleistocene age. *Evechinus chloroticus* is the commonest New Zealand urchin; and the genus is monotypic and endemic. The other species of the family Strongylocentrotidæ, *Heliocidaris tuberculata*, is a warm-water form, a migrant from the north, which occurs freely on the north-eastern coast of Australia and at the Kermadecs.

Of the third and last order, the irregular urchins (Exocycloida), nine species have been found in New Zealand. *Clypeaster virescens* belongs to a large genus, widely spread in the Indo-Pacific region. The specimens were collected north of New Zealand, and it is evidently a migrant from the north. *Arachnoides zelandiæ* is an abundant, endemic, rather ancient (Pleistocene) form; and the only other living species of the genus, *A. placenta*, is widely diffused in the Indo-Pacific region. Of the two species of the Laganidæ, *Peronella hinemoæ* is endemic, and closely related to a Japanese species,[1] *P. pellucida*; and the other has been referred to *Laganum depressum*, an Indo-Pacific species, but its identity is doubtful. *Echinocyamus polyporus* seems to be a rare species of a northern genus, which has been found in Cook Strait and at the Kermadecs.

We come now to the most interesting of all the New Zealand echinoderms, *Apatopygus recens*. It occupies in the littoral much the same position as the Tuatara (*Sphenodon punctatus*) in the land fauna; being the only living representative of a group which was abundant and widely distributed in Mesozoic times. Prof. Hawkins has examined specimens, and he tells us that "the original contention that '*Nucleolites*' *recens* is a latter-day survival of the essentially Mesozoic Nucleolitoida is perfectly justified. . . . Save for its ambulacral plating *Apatopygus* would not have been out of place on a Middle Jurassic beach" (*Geol. Mag.*, 1920, vol. 57, p. 396).

Of the three Spatangoids, *Brissopsis zealandiæ* may be endemic, but its identity is doubtful. *Spatangus multispinus*, an endemic species, belongs to a widespread, northern genus; and *Echinocardium cordatum* is interesting on account of its remarkable discontinuous distribution. It occurs freely, and is widely spread in the littoral of both the northern and southern temperate zones. The only other echinoderm which has a similar distribution is the little brittle-star *Amphipholis squamata*.

The facies of the New Zealand littoral echinoid fauna is then eminently Neozealandian, with a strongly marked distinctive character.

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[1] There is a considerable element in the New Zealand littoral marine fauna nearly related to that of Japan; and one of the extremely interesting questions to be decided by future research, is how this has come about.

Annual Meeting of the British Science Guild.

THE annual meeting of the British Science Guild was held at the Mansion House, London, on April 29 The Right Hon. Lord Askwith, president of the Guild, who opened the proceedings, moved the customary resolution that the Right Hon. the Lord Mayor of London be elected a vice-president of the Guild

Sir Richard Gregory, chairman of the executive committee of the Guild, then moved the adoption of the annual report, and directed attention to some of its salient features Reference was made to the establishment of the Norman Lockyer Lecture as an annual event. The first lecture, delivered by Sir Oliver Lodge on November 16, 1925, dealt with "The Link between Matter and Matter" It was mentioned that a supplement to the "Catalogue of British Scientific and Technical Books" (a second edition of which was published in June 1925) is in preparation. Further progress has been made, in collaboration with other bodies, with a Science Publicity Service scheme, which has now been confided to a representative committee. It is hoped to report on the cost of establishing and maintaining the service, and the prospective revenue to be derived from endowment or payment for contributions, at an early date, at a further conference of representatives of leading scientific and technical societies. A memorial was forwarded to the Board of Trade during the past year referring to the importance of scientific qualifications for a Comptroller of H.M. Patent Office. It may be permitted to hope, that this memorial, signed by many who are well known in pure and applied science, had some influence in deciding the recent appointment to this important post. Additions to the membership of the Guild have been encouraging, and useful work has been carried out by the South Australian Branch during the past year.

The resolution was seconded by Mr. F. Twyman, who alluded to important recent developments in pure science in Great Britain, and to the growing recognition of the value of applied science, as illustrated by the public interest aroused in the recent Optical Convention.

This resolution having been declared carried unanimously, Sir Richard Redmayne spoke on "The Future of the Coal Mining Industry." After pointing out the vital importance of devising a satisfactory scheme for the maintenance of this national key-industry, Sir Richard paid a tribute to the valuable summary of the position contained in the recent report of the Royal Commission. He pointed out that the depression in the coal industry is universal Germany is experiencing bad times. In the United States—which produced annually 500 million tons of soft coal (nearly twice the amount obtained in Great Britain) and where the output per man is four times what it is here—the position likewise gives ground for concern. On an average, the miner worked for only 179 days of the year during 1923 There are about 14,000 mines worked by more than 12,000 corporations or individuals.

In this depression the competition of oil-fuel is only a minor factor. It has been shown that the present methods of conducting the industry are unscientific, that selling, organisation and transport are too complex, and that many undertakings are using obsolete and inefficient machinery. Such changes as the wider use of electricity and the burning of low-temperature coke in grates can only be expected to effect partial relief. The real remedy lies in consolidation and scientific organisation of the industry, and the elimination of present wasteful methods. As an illustration of what organisation can accomplish, Sir Richard quoted the experience of the United States Steel Corporation, which by making use of the economies and possibilities of scientific method arising from consolidation, has raised the American steel industry from a position of great depression to one of great prosperity. The formation of this 'trust' has not prevented friendly rivalry between its constituents, and has led to much better relations between management and employees, who are given opportunities of taking up common stock in the concern on favourable terms.

Sir Richard therefore suggested that the solution of the problems of the coal industry lay in consolidation, involving the closing of inefficient pits and the general introduction of better organisation and more scientific methods; the industry should be controlled by an executive council, meeting daily, on which there should be workers' representatives appointed Methods of profit-sharing for the benefit of employees should be introduced, and the Government might arrange a loan, under the Trades Facilities Act, to tide over the period of reorganisation

Dr E. F Armstrong then spoke on "Dyestuffs." He recalled that the first synthetic dyestuff was an English discovery. The development of the industry in Germany was due to the fact that commercial leaders, having scientific training, encouraged the application of scientific methods and results. The War demonstrated the importance to Great Britain of maintaining an organic chemical industry. Considering the circumstances, the progress so far made in the dyestuff industry in England has been a real achievement. A highly technical industry had to be built up from the beginning To-day by far the larger portion of the hundreds of known dyestuffs are manufactured here in adequate quantity, and the standard reached is higher than that of the Continent in pre-War days. Economic difficulties have to be contended with, but substantial improvement is expected in the near future. Apart from the production of colours, described as "a miracle of applied science," manufacturers maintain a complete technical service to aid users in their application.

Capt. P. P Eckersley, who discussed "Broadcasting and the Electrical Industry," remarked that science must be applied on a scientific method. If wisely used it is of priceless benefit to mankind; if wrongly used it may prove a curse. The electrical industry presents many examples of science properly applied. British engineers combined ingenuity and solidity in their work. He agreed that we are apt to be conservative in regard to consolidation, and referred to the British broadcasting service as a shining example of the benefits of judicious amalgamation. Ninety per cent of people in the British Isles can listen to programmes with the help of inexpensive sets. The smoothness with which programmes are conducted, the manner in which an address by a public man in any part of the country can be broadcast at short notice, and the quality of the programme, are due to the consolidation of all interests in the public service. In the United States, where private interests may dominate broadcasting in some areas and disagreement between competitors may arise, the conditions are less perfect from the point of view of the public Whatever change may be made in the control of the B B.C. the fundamental methods will remain the same as at present.

A vote of thanks to the speakers, and to the Lord Mayor for the use of the Mansion House for the meeting, was proposed by Lady Lockyer and carried with acclamation Lady Lockyer mentioned that meetings had been held in the Mansion House for the last eleven years, each Lord Mayor in turn being elected a vice-president of the Guild.

University and Educational Intelligence.

CAMBRIDGE.—It is announced that Prof. E. T. Whittaker, of Edinburgh, will on May 10 deliver a lecture on "The Present State of the Theory of Light."

A change in the scheme of studies qualifying students for the Ordinary B.A. degree is proposed; by it the much-debated subsidiary subjects should be rendered more effective than at present.

The Board of Extra-Mural Studies is proposing to add to the status of the lecturers and tutors who give instruction on its behalf at various centres throughout the country The proposals recommend that such persons shall in future be appointed by grace of the Senate on the nomination of the Board, and further, that they shall come under the contributory pensions scheme for university officers. These proposals should lead to the strengthening of the position of these teachers and would be one step in the advancement of extra-mural work, an activity of the University with which the Royal Commission has shown much sympathy.

Two Robert Blair fellowships of 450*l* each are being offered by the London County Council to adult students of British nationality They will enable the holders to go abroad for a year for advanced study or research in scientific and manufacturing processes. Applications should be made to the County Hall, Westminster Bridge, London, S.E 1.

APPLICATIONS are invited by the Salters' Institute of Industrial Chemistry for a limited number of fellowships for chemists of post-graduate standing who are desirous of adopting a career in industrial chemistry. The normal value of each fellowship is from 250*l*. to 300*l*., but applications for grants of a higher value would be considered. The latest date for the receipt of applications is June 1. They should be addressed to the Director of the Institute, Salters' Hall, St. Swithin's Lane, E.C.4.

IN the University of Dacca, which was opened on July 1, 1921, the principles of a number of the recommendations made by the Calcutta University Commission of 1917–19 have been subjected to the test of practical application; with what success may be gathered from a farewell address delivered by Sir

Philip Hartog, the first Vice-Chancellor, at a meeting of the University Court last November. Chief among these principles is the residential organisation combined with a tutorial system. At Dacca three halls have been established on the lines, so far as possible, of the Oxford and Cambridge colleges, and in each of them have been started literary and debating societies, athletic societies, and social service leagues. Later a University Union was created. Whilst these halls and societies form valuable schools for character training and citizenship, the most important new element on the teaching side is the tutorial work, with the corresponding practical work supervised by the teachers in the laboratories. Much attention has been devoted to the physical welfare of students, and the executive council has decided that physical exercises ought to be compulsory for all students who are not medically unfit. There has been a notable increase in the number of Mohammedan students, from 170 out of a total of 1075 in 1921, to 353 out of a total of 1487 in 1925. The institution of the Dacca Board of Secondary and Intermediate Education, in accordance with the recommendations of the Calcutta University Commission, has not, so far, led to as much improvement as was expected. Experience has shown the need of a practical test at the intermediate examinations in science, but its introduction has been postponed *sine die*. Sir Philip Hartog remarks that the Board should be so constituted that the financial stability and progress of the educational institutions with which the members are connected would not depend on the passing of any particular number of candidates.

THE United States Commissioner of Education's report for 1924–25 concludes a tale of varied and multitudinous activities with the statement that the Commissioner travelled 43,444 miles and made 157 addresses before audiences aggregating 87,410. Specially impressive is the list of publications of the Bureau of Education, comprising, in addition to fifty-eight bulletins and the periodical *School Life*, numerous special series of leaflets relating to city schools, commercial education, health education, home economics, home education, industrial education, and other matters, library leaflets, reading courses, rural school leaflets, etc The Commissioner devotes a large share of his attention to rural education, and undertook during the year in this connexion a new type of activity, namely, co-operation on an extensive scale with selected educational organisations for the co-ordination and conduct of educational research studies. In addition, he caused a large number of special studies to be made of various aspects of the work of rural schools. His Home Education Department conducts reading courses with the co-operation of State universities or the State library commission or State normal college. The scope of the work seems to be very much on the lines of that of the National Home Reading Union in Great Britain; 1522 readers were enrolled during the year, and the number of readers who have at some time enrolled exceeds 18,500. In view of the notoriety of Tennessee's legislation on the subject of the teaching of the doctrine of evolution, it is interesting to note that a report of a survey by the Bureau's Division of Higher Education directed attention to the low proportion of the college population in that State, the inadequate financial support of the colleges, the lack of co-operation between colleges conducted under the auspices of the same Church denomination, low rates of tuition, inadequate preparation of the faculties of some institutions, and the small attendance of students from counties difficult of access

Contemporary Birthdays.

May 8, 1858.	Sir Bertram C. A. Windle, F.R.S.
May 9, 1877.	Sir James C. Irvine, F.R S.
May 13, 1854.	Dr. Marie Yves Delage.
May 13, 1857.	Sir Ronald Ross, K C.B., F.R.S.
May 13, 1851.	Sir Horace Darwin, K.B.E., F.R.S.

Sir BERTRAM WINDLE, professor of anthropology in St. Michael's College, University of Toronto, was educated at Repton and the University of Dublin Before his activities were transferred to Canada, he was professor of anatomy and anthropology in the University of Birmingham; afterwards president of University College, Cork, and whilst resident in Ireland, was much concerned with schemes of Irish education. Apart from scientific memoirs, Sir Bertram is the author of many informing books in general archæology and anthropology, including "The Romans in Britain" (1923).

Sir JAMES IRVINE was educated at Allan Glen's School, Glasgow, and the Universities of St. Andrews and Leipzic. Formerly professor of chemistry and Director of the Research Laboratory at St. Andrews, he is now Principal and Vice-Chancellor. He is an authority on the constitution and chemistry of sugars. Continuing the researches of Emil Fischer, and in collaboration with the late Prof. Purdie, he evolved new processes of investigation relating to these important natural products. Sir James was awarded the Royal Society's Davy medal last year in recognition of his work.

Dr. YVES DELAGE, professor of zoology in the Faculté des Sciences, Paris, and director of the Marine Biological Laboratory at Roscoff, was born at Avignon. He is an Officer of the Legion of Honour and a member of the Paris Academy of Sciences. Leaving teaching work at Caen (1886) he succeeded the late Prof. Milne Edwards in his professorial chair. Dr. Delage is the author of numerous monographs in experimental and general biology.

Sir RONALD ROSS, director of the Ross Institute and Hospital for Tropical Diseases, Putney Heath, received his medical training at St. Bartholomew's Hospital. Qualifying in 1881 for the Indian Medical Service, he served until 1899. It was a period fruitful in biological achievement. Following up some suggestions offered by the late Sir Patrick Manson, investigations were begun by Ross in 1895, in India, with the view of determining the life-history of the parasite of malaria (discovered by Laveran) and the transmission of infection. Ross was able to indicate the cycle of changes of the malarial organism in the tissues of a mosquito (Anopheles) which had been fed on the blood of a malarial patient. His work is the basis of modern methods for the prevention of malaria. Sir Ronald is a Nobel laureate, and a Royal medallist of the Royal Society.

Sir HORACE DARWIN may be, not inaptly, termed the apostle of methods of instrumental precision. Receiving his early training at Messrs. Eastons and Anderson, Erith, Kent, he graduated at Trinity College, Cambridge. He is chairman of the Cambridge Scientific Instrument Company, Ltd. Sir Horace gave the first Wilbur Wright Memorial Lecture before the Aeronautical Society in 1913 on "Scientific Instruments: their Design and Use in Aeronautics." It was prefaced by some interesting considerations respecting birds, the flight of insects, and 'winged plants.' Sir Horace was a member (1915 onwards) of the Munitions Inventions Panel.

Societies and Academies.

LONDON.

Royal Society, April 29.—C. H. **Best**, H. H **Dale**, J. P. **Hoet**, and H. P. **Marks**: Oxidation and storage of glucose under the action of insulin. Under the same conditions as those of the following investigation, the total quantity of glucose disappearing from the system under insulin is always equal to the sum of the equivalents of the glycogen deposited and of the oxygen absorbed. The conclusion is drawn that all the glucose disappearing under the action of insulin is either oxidised or deposited as glycogen. The fact that, in the normal animal treated with a fatal dose, the end result is often a disappearance of pre-existent glycogen, with concurrent fall of respiratory metabolism, is attributed to the other action of insulin, in depressing the new formation of carbohydrate in the liver. It is accordingly suggested that insulin in excessive doses produces the same effects as in physiological doses, but with abnormal intensity.—C. H. **Best**, J. P. **Hoet**, and H. P **Marks**: The fate of the sugar disappearing under the action of insulin. When the blood sugar of the eviscerated spinal preparation is kept at a high level for from two to five hours, by the intravenous administration of dextrose, there is no demonstrable change in the glycogen content of the skeletal muscles When a hyperglycæmia is maintained and insulin is administered, no significant part of the sugar which disappears is stored as a phosphate ester in the skeletal muscles. Under these latter conditions, however, there is an increase of glycogen in the muscles sufficient to account for from 40 to 50 per cent. of all the sugar which disappears. When the rate of sugar infusion is so slow that the blood sugar reaches a very low level under the action of insulin, the muscle glycogen is not depleted to form some unknown substance. When sufficient sugar has been available there is a recognisable increase in glycogen. Similar results are obtained when the spinal preparation has not been eviscerated. Hypoglycæmic convulsions, which are eliminated in the spinal preparation, produce a great depletion of the glycogen content of the skeletal muscles.—J. P. **Hoet** and H P. **Marks**: Observations on the onset of rigor mortis. The precipitate rigor mortis observed in rabbits dying after hypoglycæmic convulsions, or after prolonged thyroid feeding, is not due to the accumulation of the lactic acid, nor to increased acidity of the muscle The absence of glycogen and the decrease in lactacidogen of the muscle are the determining factors of this rigor. These facts must be taken into account in discussing rigor mortis and also muscular contraction —J C. **Mottram**, G M. **Scott**, and S. **Russ**: On the effects of β-rays from radium upon division and growth of cancer cells. Tumours growing in rats were exposed to measured doses of β-rays from radium. After various intervals, small pieces of the tumours were removed and counts made of the number of cells in a state of division. Immediately after a dose of radiation large enough to prevent growth of the cells *in vivo*, many cells were found in a state of division, but very soon the cells in mitosis disappeared. When irradiated tumours were left in the rats for some days after the irradiation, there was some return of cells in division, even after very large doses. The variation in the results with the interval between irradiation and examination is intimately bound up with the varying susceptibility of the cells at different stages in their growth.

DUBLIN.

Royal Irish Academy, April 12.—J. J **Nolan**: The breaking of water-drops by electric fields. Falling drops were exposed to a transverse electric field It was found that explosive bursting of the drops occurred at critical values of the field, the relation between the field and the radius of the drop being $F\sqrt{r} = \text{const.}$ This is in agreement with the observations of C T. R. Wilson and G. I. Taylor on soap-bubbles. Drops greater than 0·2 cm. radius showed a type of disintegration for lower values of the electric field than those required to produce explosive bursting. Attempts to determine the ballo-electric charge developed by the bursting of the drops were unsuccessful.

PARIS.

Academy of Sciences, April 7.—Georges **Claude**: The present state of ammonia synthesis utilising coke-oven gas. Reasons are given for the use of the hydrogen from coke-oven gas in the synthetical preparation of ammonia. Photographs are given of the works at Waziers and at Ougree. The preliminary difficulties have been to a great extent overcome, and works using the Claude process in the last quarter of 1925 produced 10,000 tons of sulphate of ammonia or its equivalent.—C. **Camichel**, L. **Escande**, and M. **Ricaud**: Viscosity and turbulence.—Max **Morand**: The luminous phenomena observed in a lithium positive-ray tube.—J **Cabannes** and J. **Granier**: The depolarisation of light diffused by some organic substances —G **Bruhat**: An apparatus for the precise determination of the orientation of a rectilinear vibration in the ultra-violet.—A. **Cotton**: Remarks on the preceding communication.—S. **Schlivitch**: Photovoltaic batteries with unalterable electrodes.—Ch. **Courtot** and C. **Pomonis**: Study in the diphenylene sulphide series. Details are given of a method of nitrating diphenylene sulphide and of the reduction of the nitro product to aminodiphenylene sulphide.—J. Roger **d'Ansan**: Remarks relating to the application of ocular gymnastics to the treatment of myopia and amblyopia.

CALCUTTA.

Asiatic Society of Bengal, April 5.—C. de Beauvoir **Stocks**: Folk-lore and customs of the Lap-chas of Sikhim. A translated collection of Lap-cha myths and fairy-tales, supplying an analysis of the ancient religion The customs and superstitions of the different aspects of Lap-cha life and industries show they are connected with the traditions of a pre-Buddhist faith —S. L. **Hora**: A short note on the distribution and habits of *Balwantia Soleniformis* (Benson). This bivalve lives in burrows excavated either in hard blue clay or in friable sandstone. The species is common in the Daleswary and the Barak rivers in Cachar. It lives in a burrow firmly anchored by its foot at the anterior end, and is enabled to enlarge it by a movement caused by the expansion and contraction of the foot. The Uriya coolies consider the animals of this species as a great delicacy and have devised an instrument for dislodging them from their burrows —J. H **Hutton**: Diaries of two tours in the unadministered area east of the Naga Hills. Notes of a tour made by Mr J. P. Mills and the author in 1923 to a part of the Naga Hills which, so far as known, has never been visited by any European except by Lt. (afterwards General) Woodthorpe in 1876 —D. N. **Majumdar**: Marriage and betrothal amongst the Hos of Kolhan.—W **Ivanow**: Rustic poetry in the dialect of Khorasan. The grammatical peculiarities of the Persian dialect spoken in the province of Khorasan are discussed, together with a large collection of rustic songs from the district of Sabzawar.—Hem Chandra **Das-Gupta**. A few types of sedentary games prevalent in the Punjab. Description of six games played with pieces on diagrams inscribed on rock-slabs or improvised on other material: (1) Dō-guti (two gutis or pieces); (2) Tre-guti (three pieces); Naō-guti (nine pieces), (4) Sher-bakar (tiger and goats); (5) Ratti-chitti-bakri (red-white goats); (6) Khutkā boiā (dug circles). The first two have, as far as known, nothing similar in other parts of India; the third has parallels in Bengal; the fourth in Bengal and Orissa; the fifth in Sumatra; the sixth in Assam, Orissa and Madras.

ROME.

Pontificia Accademia delle Scienze (Nuovi Lincei), March 21.—**Teofilato**: Some questions of ballistics.—**Martinelli**: The annual (for 1926) of the prediction office of the Ministry of Aeronautics, containing numerous notices referring to tides, terrestrial magnetism, atmospheric pressure, etc.—**Scatizzi**: The polar and essential singularities of a summable derivative with variable index.—**Neviani**: The fossil hippopotamus of the Roman Campagna: notes on new discoveries, and bibliography.—**Gianfranceschi**. Certain considerations on the numerical results obtainable with the author's formula for the distribution of energy in the black body spectrum.—Ludovici **Marini**: Climatic notes on Corfu.

Royal Academy of the Lincei, March 7.—G. A. **Crocco**: Possibility of super-aviation. The possibility of extra-atmospheric navigation is considered, and it is shown that if the weight supported is constant the power necessary for horizontal flight is proportional to the velocity, but independent of the altitude, of the flight. Further, for a given initial weight and a constant specific consumption, the amount of fuel necessary to cover a definite distance in horizontal flight is independent of both the altitude and the velocity.—R. **Nasini**: The volatility of orthoboric acid in steam. The recent denial by Anschutz and Riepenkröger that orthoboric acid is volatile in water vapour disagrees with the results of other investigators. This acid may be distilled in steam at reduced pressure if the temperature does not fall below 60°; at higher temperatures it volatilises even at the ordinary pressure. O. M. **Corbino**: The electronic theory of thermo-magnetic phenomena. The Lorentz and Gans theory, when applied to the case of a disc traversed by a centrifugal radial current of heat or electricity, predicts the formation of a circular thermo-magnetic or galvano-magnetic current of the same sense as the current producing the magnetic field. This result is, however, contrary to the truth for both currents with all metals (including bismuth) with the exception of gold, silver and copper. The theory of Livens would permit of the elimination of the contradiction in some instances, but the law of distribution of velocity on which it is founded is not in accord with the laws of electromagnetism.—S. **Franchi**: Gradual change to crystalline calc-schist and marble forms of the fossiliferous Nummulitic and Cretaceous in the Val del Gesso and the Val della Stura di Cuneo.—A. **Russo**: Mixed individuals and gametogens, neutral individuals, and pre-conjugants in the biological cycle of the ciliates, in relation to those of the metazoa.—Vasco **Ronchi**: Recent theories of flying shadows. This phenomenon is explained in the most natural and exhaustive manner by the illumination of the non-homogenous atmospheric stratum by the highly brilliant solar crescent.—A. **Rosenblatt**: Regularisation of the problem of three bodies.—A. **Ferrari**: Comparison between the diameters of the ions of one and the same element, but with different charges. The diameters of quadrivalent manganese and lead ions are respectively 2·50 and 3·10 Å.U., whereas those of the corresponding bivalent ions are 2·95 Å.U. and 3·80 Å.U.—B. **Monterosso**: Structure of *Peroderma cylindricum*, Heller.—Alberto **Chiarugi**. Phenomena of apospory and apogamy in *Artemisia nitida*, Bertol.—Umberto **D'Ancona**: Contribution to the histophysiology of striated muscle fibre.

VIENNA.

Academy of Sciences, March 18.—W. **Dorn**: Fourier's integrals considered as limiting cases of Fourier's series.—O. **Abel**: Morphological investigations on the styloid bones of horses.—M. **Belar**: Communication from the Radium Institute, No. 186. On the coloration of rock-salt by Becquerel rays.—K. **Przibram**: On the theory of the coloration of rock-salt by Becquerel rays.—E. **Flatt**: Regeneration of the long bones after partial removal in the interior of the extremities of the newt (*Triton cristatus*).—M. **Kohn** and G. **Dömötör**: The behaviour of the penta-halogen-phenols to aluminium chloride in the presence of benzole (Communication No. 20 on bromo-phenoles).

Official Publications Received.

Proceedings of the Royal Society of Edinburgh, Session 1925–1926. Vol. 46, Part 2, No. 13: Partial Differential Equations and the Calculus of Variations. By E. T. Copson. Pp. 126-135. 1s. Vol. 46, Part 2, No. 14: The Distribution of Electric Force in High Voltage Discharges. By Dr. A. E. M. Geddes. Pp. 136-148. 1s. Vol. 46, Part 2, No. 15: A Chapter in the Calculus of Variations: Maxima and Minima, for Weak Variations, of Integrals involving Ordinary Derivatives of the Second Order. By Dr. A. R. Forsyth. Pp. 149-195. 4s. Vol. 46, Part 2, No. 16: On Triple Systems of Surfaces and Non-Orthogonal Curvilinear Coordinates. By Dr. C. E. Weatherburn. Pp. 196-203. 1s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 13: On the Contents of Helium and other Constituents in the Natural Gases of Japan. By Yoshihiko Kano and Bunnosuke Yamaguti. Pp. 347-360+3 plates. (Tôkyô: Maruzen Kabushiki-Kaisha.) 75 sen.

Nigeria. Fourth Annual Bulletin of the Agricultural Department, 1st August 1925. Pp. 217. (Ibadan: Department of Agriculture.) 5s.

Ministry of Public Works, Egypt: Physical Department. Meteorological Report for the Year 1920. Pp. xix+148. (Cairo: Government Publications Office.) 20 P.T.

Report of the National Baby Week Council, 1925. Pp. 31. (London: 117 Piccadilly, W.1.)

United States Department of Agriculture. Department Bulletin No. 1395: Bats in relation to the Production of Guano and the Destruction of Insects. By Edward W. Nelson. Pp. 12. (Washington, D.C.: Government Printing Office.) 5 cents.

The Rockefeller Foundation. Annual Report for 1924. Pp. xi+447+34 plates. (New York.)

Annales de l'Institut de Physique du Globe. Fascicule spécial consacré aux expériences de la courtine sur la propagation des ondes aériennes. Pp. viii+50. (Paris: Les Presses universitaires de France.)

Poradnik dla Samouków, Tom. 6. Botanika, 1. Pp. xi+718. (Warszawa: Imienia Mianowskiego.)

Department of Scientific and Industrial Research. Second Report of the Adhesives Research Committee. Pp. iii+128. (London: H.M. Stationery Office.) 2s. net.

Transactions and Proceedings of the Royal Society of South Australia (Incorporated). Vol. 49. Edited by Prof. Walter Howchin; assisted by Arthur M. Lea. Pp. iii+324+24 plates. (Adelaide.) 18s.

Publications of the Washburn Observatory of the University of Wisconsin. Vol. 14, Part 2: Meridian Observations of Comparison Stars. By Albert S. Flint. Pp. 189-325. (Madison, Wis.)

The University of Chicago: Publications of the Yerkes Observatory. Vol. 4, Part 4: Zone +45° of Kapteyn's Selected Areas; Parallaxes and Proper Motions of 1041 Stars. By Oliver Justin Lee. Pp. v+67. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press.)

Carnegie Endowment for International Peace: Division of Intercourse and Education. Annual Report of the Director for the Year 1925. Pp. 90+5 plates. (New York.)

Diary of Societies.

SATURDAY, May 8.

Royal Society of Medicine (Otology Section) (Annual General Meeting), at 10.30 A.M.—L. Colledge: Mosher's Method of Skin Grafting.
Royal Institution of Great Britain, at 3.—Dr. P. C. Buck: The Song Form in England as represented by Parry.
Royal Society of Medicine (Balneology and Climatology Section) (at Llandrindod Wells).

SUNDAY, May 9.

Royal Society of Medicine (Balneology and Climatology Section) (at Llandrindod Wells).

MONDAY, May 10.

Royal Irish Academy (Dublin), at 4.15.
Biochemical Society (in Physiological Laboratory, St. Bartholomew's Medical College), at 4.30.—Dr. C. Dorée and E. C. Barton-Wright: A Note on the Stone-cells of the Pear.—Margaret H. O'Dwyer: On the Nature of the Hemicelluloses.—H. D. Carey: The Oxides and Oxyacids of Phosphorus by a New Method of Graphic Formulæ.—Prof. C. Lovatt Evans: Conditions affecting the Formation of Lactic Acid in Plain Muscle.—L. F. Hewitt: The Optical Rotatory Power and Dispersion of Proteins.—G. W. Ellis: A Theory on the Nature of the Absorption of Oxygen by Unsaturated Compounds.—H. P. Marks: The Determination of Small Amounts of Lactic Acid.—R. L. Mackenzie Wallis: The Corpus Luteum and Cholesterol Metabolism.—D. T. Davies, F. Dickens, and E. C. Dodds: Observations on the Properties and Preparation of the Para-thyroid Hormone (Collip).—J. G. Davis, W. K. Slater, and V. Smith: A Thermal Study of a Suggested Anaerobic Mechanism.—H. A. Abramson, P. Eggleton, and M. G. Palmer: The Fate of Sodium Lactate injected intravenously.
Royal Society of Edinburgh, at 4.30.—Principal A. P. Laurie: Modern Research on the Methods of Painting Oil Pictures as illustrated by the Technique of the Fifteenth Century.
Victoria Institute (at Central Buildings, Westminster), at 4.30.—Dr. A. T. Schofield: Religion and Science.
British Psychological Society (at London Day Training College), at 6.—F. C. Bartlett: Sublimation.
Surveyors' Institution, at 8.—Discussion on paper by Sir John Oakley on The Trustee Act, the University Act, the Land Charges Act, the Administration of Estates Act, and the Land Registration Act (concluded).—Discussion on paper by C. H. Bedells on The Settled Land Act, 1925.
Medical Society of London, at 8.—General Meeting.—At 9.—Sir Berkeley Moynihan: Annual Oration.
Royal Geographical Society (at Æolian Hall), at 8.30.—Earl Cawdor: The People of the Tsangpo Gorge.

TUESDAY, May 11.

Manchester Geological and Mining Society, at 4.
Royal Institution of Great Britain, at 5.15.—Dr. G. W. C. Kaye: The Acoustics of Public Buildings (Tyndall Lectures) (1).
Zoological Society of London, at 5.30.—C. A. Merritt Hawkes: On the Massing of the Ladybird, *Hippodamia convergens* (Coleoptera), in the Yosemite Valley.—Dr. H. H. Scott: A Mycotic Disease of Batrachians.—A. S. Le Souef: On the Habits of the Order Marsupialia.—Prof. R. T. Leiper: (a) Some Parasites of Rats in the Zoological Society's Gardens, (b) The Starling as a Factor in the Spread of Gapeworm Disease in Chickens.
Institute of Physics (at Royal College of Science), at 5.30.—H. E. Wimperis: The Relationship of Physics to Aeronautical Research (Lecture).
Institute of Marine Engineers, at 6.30.
Quekett Microscopical Club, at 7.30.—E. Heron-Allen and A. Earland: Selective Building in the Shells of the Foraminifera.

WEDNESDAY, May 12.

Royal Society of Medicine (Surgery: Sub-section of Proctology) (Annual General Meeting), at 4.30.—Prof. J. Fraser, S. Seton Pringle, G. Turner, E. Miles, and Mr. Lockhart-Mummery: Discussion on The Value of the Closed Methods in Resection of the Colon.
Radio Society of Great Britain (at Institution of Electrical Engineers), at 6.—Informal Meeting.
Royal Society of Arts, at 8.—W. S. Bradley: Industrial Welfare in Practice.
Eugenics Education Society (at Royal Society), at 8.30.—W. T. J. Gun: Some Aspects of Hereditary Ability.

THURSDAY, May 13.

Faraday Society (at Institution of Mechanical Engineers) (Discussion on Explosive Reactions in Gaseous Media), at 2.30 and 5.—Part I. Explosive Reactions Considered Generally.—Dr. W. E. Garner: Introductory Survey.—Prof. H. B. Dixon, J. Harwood, and W. F. Higgins: On the Ignition Point of Gases.—Prof. W. T. David: Radiation in Gaseous Explosions.—Dr. S. W. Saunders and Dr. W. E. Garner: Ionisation in Gas Explosions.—Dr. S. C. Lind: Ionisation and Gas Explosions.—Prof. R. V. Wheeler and Dr. W. Payman: The Uniform Movement of Flame.—Prof. W. A. Bone: Explosions at High Pressure.—Dr. Colin Campbell and Prof. H. B. Dixon: Explosion Wave in Cyanogen Mixtures.—At 7.45.—Part II. Explosive Reactions Considered in Reference to Internal Combustion Engines:—Sir Dugald Clerk: Introductory Survey.—Prof. W. T. David: Combustion in Gas Engines.—H. T. Tizard: Explosions in Petrol Engines.
Royal Society, at 4.30.—Sir Arthur Schuster: A Review of Mr. George W. Walker's Magnetic Survey (1915).—Dr. A. E. H. Tutton: The Alkali Perchlorates and a New Principle concerning the Measurement of Space-Lattice Cells.—Prof. G. I. Taylor and W. S. Farren: The Distortion of Crystals of Aluminium under Compression. Part I.—Dr. E. V. Appleton, R. A. Watson Watt, and J. F. Herd: On the Nature of Atmospherics.—T. T. H. Verschoyle: Isotherms of Hydrogen, of Nitrogen, and of Hydrogen-Nitrogen Mixtures, at 0° and 20° C. up to a Pressure of 200 Atmospheres.—*To be read in title only*:—Prof. C. H. Lees: On the Determination of the Specific Heats of Gases at Constant Pressure and at Constant Volume and their Ratio by Adiabatic Expansion.—T. G. Room: A General Configuration in Space of any Number of Dimensions analogous to the Double-Six of Lines in Ordinary Space.—C. N. Hinshelwood and W. K. Hutchison: A Comparison between Unimolecular and Bimolecular Gaseous Reactions. The Thermal Decomposition of Gaseous Acetaldehyde.—P. A. M. Dirac: (a) The Elimination of the Nodes in Quantum Mechanics; (b) Relativity Quantum Mechanics with an Application to Compton Scattering.
London Mathematical Society (at Royal Astronomical Society), at 5.
Royal Society of Medicine (Neurology Section), at 5.—Annual General Meeting.
Institute of Pathology and Research (St. Mary's Hospital, W.2), at 5.—Dr. L. Colebrook: The Chemo-Therapy of Bacterial Infections (Lecture).
Royal Institution of Great Britain, at 5.15.—Sir William Bragg: The Imperfect Crystallisation of Common Things (3).
Optical Society (at Imperial College of Science), at 7.30.—B. Graves: Microscopy of the Living Eye.—Dr. L. C. Martin: The Distribution of Light in Elementary Optical Images.
Oil and Colour Chemists' Association.

FRIDAY, May 14.

Institution of Municipal and County Engineers (North-Western District) (at Blackburn), at 10.45 A.M.
Royal Astronomical Society, at 5.
Physical Society of London (at Imperial College of Science), at 5.—L. Hartshorn: The Properties of Mutual Inductance Standards at Telephonic Frequencies.—Prof. A. L. Narayan and K. R. Rao: A Note on $\lambda 4722$ of Bismuth and the Nature of '*raies ultimes*.'—M. C. Johnson: The Distribution of Intensity in a Positive Ray Spectral Line.—Dr. E. E. Fournier d'Albe: Demonstration.
Malacological Society of London (at Linnean Society), at 6.
Junior Institution of Engineers, at 7.30.—Leslie Smith: Notes on Static Transformer Testing and Test Plant Requirements.
Railway Club (at 65 Belgrave Road, S.W.), at 7.30.—B. M. Bazley: Some Observations on Modern Locomotive Practice.
Royal Institution of Great Britain, at 9.—Seton Gordon: The Golden Eagle and its Neighbours.

SATURDAY, May 15.

Royal Institution of Great Britain, at 3.—Dr. G. C. Simpson: Atmospheric Electricity (1).

PUBLIC LECTURES.

MONDAY, May 10.

Gresham College (Basinghall Street, E.C.), at 6.—W. H. Wagstaff: Geometry. (Succeeding Lectures on May 11, 12, and 14.)

THURSDAY, May 13.

University College, at 2.30.—Sir Flinders Petrie: Recent Discoveries in Egypt.

CONGRESSES.

May 13 to 15.

Institute of Transport (at Birmingham).

May 22 to June 2.

Italian National Congress of Pure and Applied Chemistry (at Palermo).

May 24, etc.

International Geological Congress (at Madrid).

May 24 to 29.

International Ornithological Congress (at Copenhagen).

May 25.

International Society for the Protection of Childhood (at Rome).

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Science in Industry.

THE British Science Guild, the annual meeting of which was held on April 29, occupies a peculiar position among kindred societies. We have societies concerned with the promotion of science in general—notably the Royal Society—and of particular sciences such as chemistry, physics, geology, botany and zoology, and their numerous progeny—physical chemistry, biochemistry, and the rest. There are other societies—the Society of Chemical Industry is a good example—which devote themselves to the application of particular sciences to industry. The British Science Guild, founded by Sir Norman Lockyer in 1905 "to promote the application of scientific methods and results to social problems and public affairs," is not a scientific society, nor an institute of industry, nor an educational association. It is a national organisation, the chief purpose of which is to reconcile the interests of science industry, and education, and to co-ordinate their activities. Sir William Bragg, in a recent broadcast talk explaining the work of the Guild, said: "In originality of scientific work, mechanical ingenuity and operative skill, our race is in the forefront." This claim will be confirmed by the most cursory inspection of our national roll of men of science and invention. But there is something lacking, he suggests, and that is "a spirit of unity among all classes through the alliance of science, invention and labour working as a single force for national development and common welfare." To this "spirit of unity" the nation, beset by its war-heritage of financial and industrial problems, will have to pay increasing homage if it is to maintain its leading position, achieved in large measure through its "scientific work, mechanical ingenuity, and operative skill."

The traditional rôle of the British man of science is to discover fundamental scientific principles and to regard their application as a matter of subsidiary interest. Huxley, in his essay on the "Progress of Science," says that the history of physical science teaches that the practical advantages it offers never have been and never will be sufficiently attractive to men inspired by the inborn genius of the interpreter of Nature to give them courage to undergo the toils and make the sacrifices which that calling requires from its votaries. Their real stimulus comes from the joy of discovering the causes of things—from "the supreme delight of extending the realm of law and order ever farther towards the unattainable goals of the infinitely great and the infinitely small between which our little race is run." He refers to the practical applications of science as the "flotsam and jetsam of the tide of investigation" destined to be turned into the wages of workmen and the wealth of capitalists while the wave of scientific investigation advances proudly over the ocean of the unknown.

If Huxley adopted an exalted view of the value of pure scientific investigation, he recognised that the interests of science and industry are identical. There is happily an increasing recognition of the need for "the alliance of science, invention and labour" for which Sir William Bragg pleads, a need often illustrated by our scientific and industrial history. The classical example of the traditional rôle of the British man of science is provided by the history of the aniline dye industry, based on Sir William Perkins's discoveries. It is of interest to recall that when Perkins discovered, in 1856, the first aniline dye, 'mauvine,' he was working on the constitution of quinine. Diverse explanations have been offered of our failure to establish a great industry at an early stage on the basis of these discoveries. It has been said, for example, that after the death of the Prince Consort, Hofmann abandoned his professorship at the Royal College of Chemistry and returned to Berlin, taking with him a band of workers who possessed the expert knowledge of the aniline dyes. The late King Edward VII.'s great interest in the technological developments at South Kensington was due—so he assured Lord Haldane—to the fact that this work would have been accomplished by his father, the Prince Consort, but for his premature death. Others have suggested that the fate of the aniline dye industry in Great Britain was sealed by the control which English chemists exercised through their patents, by which so much money was made that they ceased to care whether the industry developed further.

Whatever may have been the cause, the dyestuffs industry in Great Britain was neglected, and the Germans took it up and by skill and patience developed the industry on a scale of which we are, alas, too often reminded. How much effort and money—both private and public—have been expended to recover the lost ground and what serious risks we have run in the meantime, even as regards our national security? Dr. E. F. Armstrong, in the course of his address at the annual meeting of the British Science Guild, while admitting that the fight is not yet won, was able to express optimism as to the future. He stressed the need for the application of scientific method to technical success, adding, however, that "it is more than ever true that without commercial prudence and ability, complete success is unlikely." The harvest of research ripens slowly, but the industry is finding its faith in research justified. At the present time the dyestuff industry in Great Britain is protected not by a tariff, but by absolute prohibition of the import of dyes and intermediates, except under licence, and it is satisfactory to learn that few licences are granted on the grounds of quality or price.

The original dyestuff industry in Germany, as Dr. Armstrong reminded his audience, grew into a synthetic organic chemical industry manufacturing drugs and many other synthetic products of everyday use. In addition, the industry became "a potential arsenal for chemical warfare." The improvisations made by Britain during the War involved mistakes which were paid for in human life and treasure, "but right well was the work done by our chemists; and the country can never repay, nor should she ever be allowed to forget, the debt she owes to them." Their work is being continued, and the dyestuff industry in Britain has made progress which, all things considered, is regarded as a real achievement by those in a position to judge.

The artificial silk industry occupies a brighter page in the scientific and industrial history of Great Britain. The silk thread is and has always been a manufactured article, not a natural product, whether the agent be a silkworm or a chemical worker. So long ago as the early years of the eighteenth century, Réaumur realised that what a worm could do, civilised man might also hope to accomplish. M. Bon at about this time produced gloves and stockings from a yarn formed from the web of the familiar domestic spider. The inventor and pioneer of the artificial silk industry, Hilaire de Chardonnet, deliberately applied his chemical knowledge to this problem. He succeeded in transforming cellulose into a soluble colloidal form, which he converted into a thread, and on the basis of this discovery he founded a factory in his native town, Besançon, and established a successful industry. Other processes followed, such as the Lehner process, established in Switzerland.

Of special interest to British chemists is the viscose reaction and process, by which cellulose in the form of wood-pulp is synthetically converted in two stages into the water-soluble sulphocarbonic hydrate ester. This process, discovered in 1892, was an incident in a sustained study of alkali-cellulose and the mercerising process conducted by Cross and Bevan from the year 1880. At the appropriate moment, the inventor gave invaluable assistance in the industrial application of the discovery. The industry is greatly indebted to the invention by C. Topham of the centrifugal spinning box known as the 'Topham box.' Finally, the necessary capital and enterprise were forthcoming for commercial exploitation. Messrs. Cortaulds took over the viscose experimental plant at the Kew works of the Zürich Lamp Company in 1904, and established new works at Coventry in the following year. But it was not until

1907 that the process was sufficiently advanced for industrial application on a large scale.

Another process for artificial silk production—the product is now known as 'celanese'—is based on cellulose acetate, the familiar aeroplane dope of the War, manufactured by the process of H. Dreyfus. In this case a great War industry was turned to a peaceful application. Many other processes for the production of artificial silk have been devised both in Great Britain and on the Continent. The exploitation of cellulose in its various forms has indeed attracted intensive and sustained study throughout the world. It is gratifying, especially to those who remember the chequered history of the aniline dye industry in Britain, that the viscose process, a triumph of British science and industry, has now acquired such an assured position.

Both men of science and men of affairs should read, mark and digest those contrasted histories. Their moral is fairly obvious. We have outgrown and outlived the Victorian age with its smug complacency, its narrow political creeds, its devouring animosities. To create a new world from these smouldering embers, we must recapture the Elizabethan spirit of adventure and combine with it "a spirit of unity among all classes through the alliance of science, invention and labour working as a single force for national development and human welfare."

T. LL. H.

Carbon and Silicon: the two Foundation Stones of the World.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. By Dr. J. W. Mellor. Vol. 6. C. (Part II). Si. Silicates. Pp. x+1024. (London: Longmans, Green and Co., 1925.) 63*s.* net.

DR. MELLOR tells us that the proverb 'diamond cut diamond' is of Hindu origin and that, "consonant with their mystic temperament and glowing imagination, the Hindus consecrated the diamond to their chief gods and attributed to it sovereign virtues."

Our temperament is such, that though mystics may prosper among us, we seem to have no imagination. If we had the least, we should worship diamond as the basis of life and every chemist would proudly display the gem as his sign of office. Every chemist, too, would marvel greatly at the properties of silicon and would seek to contrast them with those of carbon—one the symbol and substance of mobility and life, the other almost that of fixity and death. As it is, the physical chemist learns nothing of the chemistry of carbon and of life and less of that of silicon and silicates, the organic chemist nothing of silicates, though these pave the earth. Silica we can show but sadly, shut up in secrecy—yet we make gems of it and so honour it in silence.

This is the sixth volume of Dr. Mellor's stupendous treatise. Carbon and silicon, chiefly the latter, are the subject matter. It is impossible to do justice to the greatness of his work—to rate it at its proper value, to appreciate the truly scientific spirit in which, throughout the years, he has wrought for us, the excessive modesty of his presentation, his wondrous talent as a compiler, his almost uncanny faculty of unearthing information, his power of curt expression and concise statement, his logical, unbiassed attitude. That one man should accomplish so much is more than remarkable. Knowing him and having had the privilege of admission within his sanctuary, I have some understanding of his method and temperamental peculiarities, including his match-devouring capacity and his phlegm: but all may read his character in his work, if they will. What is not known is the wonderful manner in which the ways of his life are made smooth by the care of a devoted wife. Little as he is seen in the world, all who know him are his admirers and friends. He is not only the bibliophile and dictionary maker but himself a scientific worker and has long been scientific leader of the pottery industry. How entirely our Royal Society system fails in recognising scientific worth, how partial it is in its judgments, is shown by the fact that the Society, to our great loss, does not yet number him among its fellows.

Dr. Mellor's books are not for babes but every one who aspires to be rated a full-grown chemist should possess them and ponder their every page, scarce one of which does not offer many problems. They are costly but worth whatever sacrifice their purchase may entail. We may hope that when teaching is made rational and the farce is no longer perpetrated of calling upon students merely to memorise and reproduce, the existence of books such as Mellor's will be recognised and they will be treated as living instruments. Then, proof of power to read, interpret and *use* them, whenever occasion arise, will be asked for, instead of the parrot-like memorised acquaintance with the text-book now forced upon students.

The real value of the treatise lies in the demand its statements make upon the intelligence—the aid they afford as a key to the literature. Any one who has learnt to use it will have learnt to read: to ask himself what can be the meaning of the numerous, often diverse and irreconcilable statements that are on record. Indeed, the book is only to be read with full profit if it be read always in a critical comparative spirit. The author's attitude is nearly always non-committal: "Here are the statements for which you have paid me three guineas a volume, now take your choice." He never adopts the clerical (? neo-chemical), dogmatic attitude: perhaps he too rarely sums up or makes statements of odds. It is this quality, however, that gives all his writings their peculiar value and charm.

It is impossible to turn over the pages of such a book without being constantly reminded how incomplete and unreasoned is our knowledge. Take the question of the forms of carbon—"are graphite and the various 'chars' distinct forms of carbon, different from diamond?" It is clear, from X-ray analysis, that the carbon in graphite and in 'chars' is, at least in part, different from the carbon in diamond. The structure of the diamond, as determined by Sir William Bragg, is that we should expect on general chemical grounds. It may be regarded as a close-packed assemblage of regular tetrahedra. If we dissect out of a layer, a 'string' of the atoms and fully clothe these with hydrogen, we obtain a paraffin hydrocarbon—a linear assemblage in which lines drawn between the centres of contiguous carbon atoms meet at the tetrahedral angle. If, instead, we dissect out a hexagonal block of six carbon atoms and surround the system with only six hydrogen atoms, we get benzene. Graphite is clearly benzenoid and so are the chars, even the ground substance of coal: still, proof has yet to be given that pure graphite is carbon and carbon only. Sir Charles Parsons has been led to the conclusion, that no valid proof has yet been given that diamond can be produced from 'black carbon' nor indeed from any carbon compound. The heat of combustion of graphite is stated to be so near to that of diamond that a close equilibrium between the two forms is to be expected—if, indeed, they be allotropes. However complex, a purely benzenoid structure would scarcely involve blackness—this is rather to be regarded as proof of the presence of ethenoid carbon in addition to benzenoid. The writer has long inclined to the view that there is but one carbon—the diamond form—and that graphite and the black chars are hydrocarbons in which, may be, only a minute proportion of hydrogen atoms is present, yet sufficient to prevent the system lapsing into diamond.

Examination of the statements brought together by Dr. Mellor with reference to a second form of silicon but lends support to this view—in this case also there is no clear 'proof' of the existence of more than one form of the element.

It is surprising how little attention has been paid to silicon. Carborundum, which is next the diamond in hardness, also has received far too little notice. A colourless, crystalline compound, half carbon, half silicon, a product of the electric furnace, it has revolutionised the practice of machining steel work and almost made the file unnecessary but the chemist has paid it scant attention. What exactly is its structure? X-ray analysis has at least given the interesting result, that the distance apart of the atomic centres is considerably greater than that of the carbon atoms in diamond. A strict comparison is needed of the diamond with silicon and the intermediate carborundum. These fundamental problems, strangely enough, receive but indifferent attention, yet they are of surpassing interest.

Again, though it fashions the world and we are made from it, we pay no heed to carbonic acid—it's such a little one in acidity. Mellor gravely puts K_1 as 23,000 times K_2, according to some great authority's calculation, then quietly writes the formula $\begin{matrix}HO\\HO\end{matrix}\!\!>\!C:O$. Reading between the lines, it is easy to see that we simply do not know what the acid is. It is not bibasic, if the evidence have any force that Worley and I have adduced, indicating that sulphuric acid is unibasic. Still, in all our student's bibles *it is written* that it is—who shall say that our science is not a religion, based upon faith, not fact; who, that we do not need a sense of humour to grasp its contradictions and more imagination to guess its riddles.

Nothing is more striking, in turning over Dr. Mellor's volumes, than the evidence they afford of our casual and unregulated methods of attack: creatures o impulse and opportunity, particularly of fashion, as we are, 'science' thus far has done little to put its big house in order. Thus, a vast amount of work has been done upon the heat of combustion of carbon compounds; yet the fundamental constant, the heat of combustion of carbon proper, in its several forms, has never been subjected to experimental criticism. The values on record are clearly open to question and the discrepancies are not slight. Such an inquiry would obviously be laborious and difficult: the vaunted 'research habit' that is now coming upon us is one which tends rathe to the cultivation of the armchair problem and high-frequency advertisement.

The importance of the volume before us is to b found in the display it makes of the silicate maz Never before has so vast a body of information upo the subject of silica and its combinations been lai bare for inspection but how disconcerting is th picture. Take statements such as the following:

> "The molecular theory of organic chemistry finds n application in the chemistry of the silicates. . . Although the existence of definite radicles is bein recognised, yet the condition of this branch of chemistr is very like that of organic chemistry before Avogadro' hypothesis had been adopted as a guide. Suc molecular formulæ as we have are, at present, o doubtful validity. After all has been said, the con stitution of the silicates is not much in advance o A. Laurent's time, when he could say in his 'Memoi sur les silicates':
>
> "'We have a silicate that contains $Si_{13}O_{31}Mg_{21}Al_4H_2$ and we discuss seriously whether the atoms hav

the arrangement $(11SiO_2 . 21MgO)$ $2(SiO_2 . Al_2O_3)$ 15Aq; or $7(SiO_2 . 3MgO)$ $2(3SiO_2 . Al_2O_3)$ 15Aq; or $7(SiO_2 . 3MgO . 2H_2O)$ $2(3SiO_2 . Al_2O_3)$ Aq; or a hundred other similar formulæ. What is there to prove that the silica is distributed into three principal groups; that the magnesia forms two distinct combinations; that the water occupies two different places? Does this salt by its reactions split into magnesian silicate on the one hand and an alumino-magnesian silicate on the other? I have often read the discussions that have taken place on this subject and I avow that I have never found anything but what was arbitrary or according to routine; what I saw most clearly was that, in general, the greatest regard was paid to authority. . . . We should arrive at results quite as satisfactorily by putting the atomic letters of a formula into an urn and then taking them out, haphazard, to form dualistic groups.' "

Is it right, however, to say that the molecular theory of organic chemistry finds no application in the chemistry of the silicates? The peculiarity of the silicon atom seems to be its great love for oxygen combined with an astounding platonic readiness to share its love with a neighbouring atom of its own kind. I am tempted to think of quartz as built like paraffin-wax, oxygen taking the place of hydrogen, each pair of atoms being shared by two silicon atoms. Just as CH_2 is the ultimate unit in the one, so $Si{}^{O}_{O}$ may be the ultimate unit in the other. We may picture the oxygen atoms climbing, as it were, like monkeys, spirally, up a pole of silicon atoms joined in zig-zags, just as are carbon atoms in stearic acid.

The high-temperature, optically inert form of silica, crystobalite, may conceivably be an ethenoid form of silica more akin to carbon dioxide. The X-ray workers would have us regard the silicon atoms as unpaired and linked by oxygen, each as in touch with four oxygen atoms. If so, we must think of silica in terms of oxygen rather than of silicon. The amazing hardness of quartz is astonishing from this point of view: oxygen seems to provide no soft cushion for silicon to rest upon. We ask for "more" and perhaps more chemical feeling from the rays before deciding. The key to the interpretation of silicates may well be found in petrology—a discipline thus far despised and neglected of chemists—in the study of their evolution as minerals. The chemist who is both chemist and petrologist, with geometric sense and power to interpret X-ray indications, will have open to him a vast and fertile field of exploration. The volume under notice may serve to inspire such a man. Our present neglect of geology is criminal.

Chemist and physicist need put their heads together, if we are ever to solve the problems. The development of pyro- and piezo-electric effects in quartz may be taken as an example. These are regarded by physicists as an intrinsic property of its substance. Quartz seems, however, to be an electrolyte, because of the presence of included silicate. It seems likely that all such effects in crystals are of secondary origin—perhaps mere frictional electricity manifestations.

Dr. Mellor, perhaps unfortunately, makes no attempt to paint broadly the character either of carbon or of silicon and deals with only a few of the simple compounds of carbon. It were time that we developed such themes in setting ourselves cross-word puzzles. We assume that we understand carbon. Supposing that the would-be silicon chemist were to ask: 'What precisely are the ways in which carbon can associate with carbon? I wish to be clear, in order that I may apply your experience of carbon to silicon. Mellor nowhere tells me.' Can we answer?

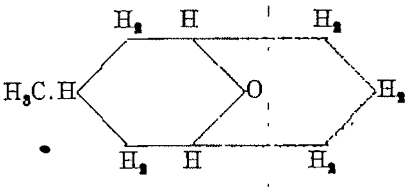
Making this and that statement, we should soon be pulled up. If our friend had the sense of logic he would soon say: 'Yes, you make that assertion but upon what evidence?' Upon revision, organic chemistry seems to the writer to be in a very loose state. It is far too much upon paper. We have made no proper use of the gift the gods would give us. Van 't Hoff began to think in terms of the solid but he only began; he made no full, logical use of the model he adopted. Probably he was carried away by the wonderful consequences of his hypothesis, by finding a satisfactory method of explaining optical activity and so, without inquiry—he was but imperfectly fledged as a chemist—fell in with the current practice of thinking in terms of single, double and triple bonds. So it came that he pictured tetrahedra as united apex to apex in paraffinic, edge to edge in ethenoid, face to face only in acetenoid compounds. He made no attempt to arrange his models in close-packed systems: in fact he took no notice of crystallographic problems.

A solid model of the carbon atom is best made by truncating a regular tetrahedron, so that each face is reduced to a hexagon, by substituting for each of the solid angles a three faced pyramid. When such "tetrahedra" are close-packed, face to face, they form a rigid mass—which is precisely the structure of the diamond, as disclosed by X-ray analysis. We have to picture the four affinities each as directed towards the centre of a face, not to the apex of the tetrahedron. It may be added that only one other form of packing, presumably the ethenoid, is possible.

The consequences of such treatment of the problem are of moment. Limitations are introduced not hitherto foreseen. The models are more suitably made by fitting four rhombic dodecahedra symmetrically together. These may be joined in line, with zig-zag centres, without restriction of length, as in paraffins.

They may also be grouped in closed systems of six, fitting closely, without stress or strain—as in hexamethylene and benzene. The arrangement in these cases is that of the diamond. A compact, symmetrically closed system cannot, however, be formed with less than six carbon atoms. Three tetrahedra can be arranged in paraffinic order but one and three then only touch at a single dodecahedral face. If the three be placed symmetrically, the third, in the median position, is in contact with one and with two at only three dodecahedral faces, that is to say, the contact is only three-eighths that of the paraffinic type; moreover, the three atomic centres are not equidistant. Four may be arranged symmetrically, in which case one and three are united as are the two in the 'symmetrical' arrangement of three, three-eighths as firmly as in a paraffin. The difficulty is with five—one and five touch at only a single dodecahedral face: yet we are told that hexamethylene rapidly passes over into methylpentamethylene. The polymethylenes, therefore, should be a fascinating field for X-ray study. Prof. W. H. Perkin has synthesised a great number of tri-, tetra- and pentamethylene derivatives: it is assumed that these are all closed systems. Convincing evidence of such constitution is needed. Prof. Perkin is known as a great user of the word 'research': by his unrivalled preparative skill he has enriched our lists with a great variety of new products. Let us hope that he will now turn to analytic studies and do a little *re*-search in his own field, so that we may learn to know his numerous progeny better and feel satisfied that they are rightly baptised. Gomberg's work has prepared us to receive surprises. We have too long talked in terms of rings. Our minds are hypnotised by looking always at loosely-strung formula.

One case is clear, that of camphor; this cannot be what it is supposed to be, a dipentamethylene derivative, which is nothing short of a geometrical impossibility. A possible, if not probable, alternative formula is the following:



In this, three carbon atoms are common to two hexamethylene groups. The dotted portion is to be thought of as upright upon the undotted. Almost every change wrought upon camphor probably involves molecular rearrangement —like the juvenile game of chairs, in which almost every child gets up and only some recover their original seats.

The suggestion the writer would make to chemists generally is that we be 'off' with the old before seeking new loves among elusive electrons and polar affinities: that we set our own rather untidy house in order before inviting our colleagues to visit and inspect us with their variously penetrating rays.

HENRY E. ARMSTRONG.

Guides to the French Fauna.

(1) *Faune de France.* Par J.-J. Kieffer. 11: Diptères (Nématocères piqueurs); *Chironomidæ Ceratopogoninæ.* (Fédération française des Sociétés de Sciences naturelles: Office central de faunistique.) Pp. iii+139. (Paris: Paul Lechevalier, 1925.) 18 francs.

(2) *Faune de France.* Par E. Séguy. 12: Diptères (Nématocères piqueurs); Ptychopteridæ, Orphnephilidæ, Simuliidæ, Culicidæ, Psychodidæ, Phlebotominæ. (Fédération française des Sociétés de Sciences naturelles: Office central de faunistique.) Pp. iii+109. (Paris: Paul Lechevalier, 1925.) 15 francs.

(1) THE two most recent fascicules of the "Faun de France" treat of those Diptera Nematocera that have piercing mouth-parts and blood-suckin propensities. The late Abbé J.-J. Kieffer's monograp of the subfamily Ceratopogoninæ provides a concis and up-to-date guide to the study of these small an obscure midges. Prior to about 1900, only about seve European genera were recognised, but during the las twenty-five years quite three times as many hav been disclosed as inhabiting France alone. In tha period we have learned something of the metamorphose of several, and also that some of these flies have th curious habit of sucking the blood of other insects The Abbé's diligence as a systematist has raised hin to the front rank as an authority on the group, and i is satisfactory that he has brought together so muc recent information in a convenient compass.

(2) The remaining blood-sucking groups are treate by M. Séguy, and the most important of these are th Culicidæ, which are held to include also the Dixid of many writers. This family is dealt with in th amazingly small number of 39 pages, which is onl attainable by the use of synoptic keys in place o detailed descriptions—a feature adopted throughou the "Faune de France" series. It is almost amusin to note that after all the nomenclatorial shiftings th yellow-fever mosquito has been subjected to, tha M. Séguy has thought fit to go back to its old nam *Stegomyia fasciata.* The minute papatasi flies (Phle botomus) include four species, and there are twenty four species of Simuliidæ enumerated.

In addition to the above blood-sucking forms, th two small families Ptychopteridæ and Orphnephilidæ are included, the last-mentioned being represented by a single species: its larva and pupa are figured after the recent work of Saunders in Cambridge. Uniformity of treatment and arrangement, in spite of its being the product of a number of specialists, are by no means minor features maintained in this useful guide to the French fauna. Its cheapness and handy proportions raise the wish that something corresponding to it existed with regard to animal life in Britain.

A. D. I.

Colliery Management.

Colliery Working and Management: comprising the Duties of a Colliery Manager, the Superintendence and Arrangement of Labour and Wages, and the different Systems of working Coal Seams. By H. F. Bulman and Sir R. A. S. Redmayne. Fourth edition, thoroughly revised and much enlarged. Pp. xv+393+32 plates. (London: Crosby Lockwood and Son, 1925.) 42*s.* net.

In the opening sentence of Chap. iv. of this work the authors ask: "What manner of man ought a colliery manager to be?" Their answer to this question should be read by all those self-elected critics who at the present time single out the coal-mining industry, from all the industries of Great Britain, in order to level wholesale charges of inefficiency. A perusal of this book reveals the wide knowledge of pure and applied science, and of sociological, commercial, and other problems, required by the colliery manager of the present day.

The book takes a broad view of the British coal-mining industry from the outlook of the colliery manager, and may be read with profit by any one concerned with the control of collieries, or by the general reader inclined to examine for himself the present condition of the science and art of mining. In Chap. i., and indeed throughout the book, interesting historical references are given to show the gradual development in technique and administration through the long history of the industry, and modern methods and practices are also described.

Of special interest is the description of past and present conditions of labour in Chap. iii., and the very full account of the events leading up to the present system of regulating wages under the National Agreement of 1921. Chap. vi. describes the organisation of labour above and below ground, and Chap. vii. gives in detail the elaborate and complicated method of making up wages bills and cost sheets. The remainder of the book is devoted to a discussion of technical methods. Chap. xviii. deals with accidents and their prevention.

The long experience of the authors in the north of England is shown by the slightly greater length devoted to descriptions of practices in this coalfield, although other coalfields are by no means neglected. In any case the authors may be forgiven this slight bias, as the leading part played until recently by the Great Northern Coalfield has undoubtedly influenced practice in other coalfields not only in Great Britain but also all over the world.

Douglas Hay.

Our Bookshelf.

Introduction to Theoretical Physics. By Prof. Arthur Haas. Vol. 2. Translated from the third and fourth editions by T. Verschoyle. Pp. x+414. (London: Constable and Co., Ltd., 1925.) 21*s.* net.

In the second volume of his treatise on theoretical physics, Prof. Arthur Haas maintains the same high standard as in the first volume already noticed in these columns (Nature, vol. 116, p. 267, 1925). The author has wonderful skill in summarising the results of recent investigations, and a sound instinct for the really important parts of his subject. The book is remarkable not only for the power of condensation exhibited, but also for the wide range of the subject matter. It is difficult to judge how the work would appeal to a reader without much previous knowledge of the subject, but it may be questioned whether the unprepared student would not find the treatment in places too condensed and the pace too fast. Thus in the very first chapter he is introduced to three types of elementary quanta—the quantum of electricity, the quanta of positive corpuscular radiation, and the quantum of action.

The quantum theory of the hydrogen atom forms the subject of the second chapter. The subject of Rontgen rays is then taken up, and an account of exceptional interest is given of the behaviour of crystals with respect to these rays. The theory of the elements, taking Moseley's law as a starting-point, forms the subject of the next chapter, and the Part of the volume dealing with atomic theory concludes with an excellent account of the general theory of spectra. Part IV. of the whole treatise deals with the theory of heat, and includes chapters on statistics and thermodynamics. The volume concludes with an exceptionally lucid discussion of the theory of relativity. Prof. Haas has supplied a brief summary of the more important work carried out between the publication of the German edition and of the present English edition of Vol. 2. The translation into English has been admirably done by Mr. Verschoyle, who acknowledges his indebtedness to Dr. R. W. Lawson.

It was no doubt impossible in the space at the author's disposal to give due credit to all the investigators who have made important contributions to the subjects described, but we are surprised to find no reference to Perrin's work on the Brownian movement, or to Richardson's work on thermionics. These are but minor criticisms, and we would conclude by giving a warm welcome to a truly noteworthy book.

H. S. Allen.

The Alkali Industry. By Prof. J. R. Partington. (Industrial Chemistry Series.) Second edition. Pp. xii+344. (London: Baillière, Tindall and Cox, 1925.) 12*s.* 6*d.* net.

Prof. Partington's "concise and connected sketch" of the alkali industry—to use his own words—was first published in May 1918, reprinted in December of the same year, and attained the dignity of a second edition towards the end of 1925. Its merits are many and its defects but few. Written by an academic chemist mainly for students, it is superior to most of the text-books covering the same or similar ground on account of its conciseness, its clarity and accuracy, and the judicious application of the law of mass action and of modern thermodynamics. It is also far more up-to-date than the average text-book. The few defects we have noticed are mainly due to virtues practised in excess. Thus the very concise writing, necessitated by the extent of the subject matter, introduces a 'staccato' touch that makes continuous reading a little irksome; and emphasis on the scientific aspects has subordinated such mundane considerations as costs and yields, matters of vital importance to the budding technologist. Exception has rightly been taken to the title of the book, because almost as much space has been given to acids, etc., as to alkalis: a better title would have been "The Heavy Chemical Industry," which is sufficiently vague and comprehensive for the author's purpose.

In a few respects the information given is not so precise or up-to-date as it might have been. For example, the production of synthetic ammonia in England is referred to in several places; on pp. 1 and 262 we are told that the process is operated by Brunner, Mond and Co., at Billingham-on-Tees, but on p. 199 it is stated that the factory there "is said to be operating." Many erroneous statements have been made by technical writers concerning this manufacture, yet the chairman of the Company, in his address to the annual general meeting in May last year, said that the plant for making 30 tons of ammonia per diem (equivalent to 114 tons of ammonium sulphate) had been operated for a long time, although below its output-capacity, and that it was being enlarged to produce 50 tons. In May 1925, the 30-ton plant was running smoothly at full capacity and showing profits; and measures were being taken to increase the production to 200 tons of ammonia a day.

Drawing: its History and Uses. By W. A. S. Benson. With a Memoir by the Hon. W. N. Bruce. Pp. xxxiii+109. (London: Oxford University Press, 1925.) 6*s.* 6*d.* net.

The author of this little book, who died in 1924 in his seventieth year, was a lifelong exponent of artistic expression in various forms rather than an artist in any conventional sense. His association with William Morris gave a bias in his attitude towards art which finds expression in the opening sentences of his book, in which he lays it down that the variety of purposes for which drawing serves in education and in life is not too well understood; it is not merely a gymnastic exercise or an introduction to the fine art of painting, but a mode of expression, an alternative to speech from which all forms of written language have arisen. In support of his view he traces the growth of graphic art from its earliest beginnings in the palæolithic cave, through the conventional decorative art of the neolithic period, and analogous stages of culture, in which *motif* is dependent directly or indirectly on the technique demanded by material, and through the artistic formula which gave rise to the art of writing, to the modern picture in its frame, and its relation to interior decoration. The treatment of the subject is stimulating, and it may be hoped will bring home to a wider public the significance of early forms of art less well known than that of palæolithic man.

Natur und Mensch: die Naturwissenschaften und ihre Anwendungen. Herausgegeben von Dr. C. W. Schmidt. Erster Band: Weltraum und Erde. Von Dr. H. H. Kritzinger und Dr. C. W. Schmidt. Pp. xii+494+30 Tafeln. (Berlin und Leipzig: Walter de Gruyter und Co., 1926.) 36 gold marks.

This is the first of four volumes which are planned to cover all aspects of natural history in its widest sense, including geology, botany, zoology, ethnology, and the application of scientific knowledge. The first volume deals with astronomical and geological problems, the latter including physical and historical geology and mineralogy. The chapters are popular without being childish, and cover the ground with remarkable thoroughness. They are admirably illustrated with diagrams, beautifully reproduced photographs, and a few coloured plates. In fact, the book is lavishly produced, and as a popular work should make a wide appeal, even though the price is somewhat high.

Economic Geology. By Prof. H. Ries. Fifth edition, revised. Pp. v+843. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1925.) 25*s.* net.

This fifth edition of "Economic Geology," like its predecessor the fourth, deals almost wholly with the economic geology of North America. Its excellent illustrations, numerous references, and good index, together with its balance of treatment as regards scope and descriptive detail, make it a useful and popular text-book so far as the deposits of economic minerals in North America are concerned. As regards deposits other than those of North America, however, it is much less satisfactory. Indeed, in this respect it needs both amplification and correction, and the author would do well in future editions either to make these amplifications or adopt a more appropriate title, as was done in the first three editions.

Two Ornithologists on the Lower Danube: being a Record of a Journey to the Dobrogea and the Danube Delta, with a Systematic List of the Birds Observed. By H. Kirke Swann. Pp. vi+67. (London: Wheldon and Wesley, Ltd., 1925.) 5*s.* net.

This is a slim volume by the late Mr. Kirke Swann describing an ornithological visit to the Rumanian reaches of the Danube. The region is but little known to British ornithologists, and at the present time official restrictions make it an inconvenient one to visit. It is, however, rich in interesting birds, notably in birds of prey and in members of the heron family. Mr. McNeile adds some photographs of nests, and of the people and local scenes.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Eclogite and the Surface History of the Earth.

The interest which has lately been evinced in the surface history of the earth has necessarily extended to the nature of the substratum underlying continents and oceans.

There appears to be general consensus of opinion that this, in its higher levels, is basaltic in character. The evidence for this is strong, and no opposing evidence of importance appears forthcoming. The physical properties of basalt are in every respect in agreement with the requirements.

But there appears to be a certain amount of evidence that at greater depths a change of character may occur. The evidence is mainly seismic, and seems to indicate material of higher density existing at levels which have been indicated as at 60 km. beneath the continental surface (Mohorovičić) and again at 40 km. beneath the oceans (Angenheister). It is generally held that such a discontinuity may be due to deep-lying peridotite, an ultra-basic rock having a density of about 3·4 and the existence of which beneath a basaltic covering has, on petrological grounds, a certain genetic probability. In my writings upon this subject I have referred to this view and to the consequences which must arise as affecting the periodicity and magnitude of the 'revolutions.'

The possibility that eclogite may be the deep-lying substance has been suggested by several writers It is with reference to the physical consequences which may be expected to arise, should this suggestion be correct, that I would revert to the subject. I am not aware that these consequences have been pointed out previously.

Eclogite is generally classed by petrologists among the ultra-basic rocks. The classification is somewhat misleading, however. There is little or no chemical difference between eclogite and basalt, although these two rocks are very unlike in appearance and mineral composition. In Rosenbuche's "Elemente der Gesteins Lehre" (1898) six analyses of eclogite are cited. The means agree with those for gabbro and basalt as averaged by Daly or as determined by Washington for the plateau basalts or the basalts of the volcanic islands. A molten eclogite must differ in no respect from a true basaltic glass.

The physical properties of the two types differ, however, in a very important respect; the density of solid basalt is about 3·0; that of eclogite 3·4 This difference would, of course, cause it to affect the propagation of seismic waves just as would peridotite. The mineral composition of eclogite is radically different from that of a gabbro or basalt. It consists mainly of a pyroxene and a garnet, the latter having a density of about 3·7. It is the abundance of this mineral (which may be regarded as replacing the normal plagioclase and olivine of the gabbros) which confers its high density upon the rock. It is significant that this mineral shows unmistakable signs of instability. "Its presence," write Hatch and Wells in their recent valuable "Petrology of the Igneous Rocks," "indicates consolidation under very great pressure, otherwise its components would have appeared as olivine and plagioclase. Eclogite is, therefore, heteromorphous with gabbro."

It is very probable that at the great pressures prevailing deep in the substratum this rock would come into existence. No process of magmatic differentiation is required. When the basaltic magma had parted with its heat of liquefication, and in the course of sufficient time, we may expect that this substance will take the place of the magma. Of course, this view does not negative the possibility that peridotic layers, resulting from magmatic differentiation, may also exist

The presence of a deep-lying stratum of eclogite carries with it consequences the significance of which may be considerable and which, indeed, may have played an important part in the events of the surface history of the earth. This appears when we consider the great volume-change which must attend its liquefication, and again its subsequent resumption of the solid and crystalline state. For in the fluid state it possesses the density of a basaltic glass; when it is finally consolidated and crystallised it possesses the density of a true ultra-basic rock.

It is probable that under the conditions of viscosity prevailing in the depths a considerable time-element must enter into its resumption of the crystalline state. But there is abundance of time. The effects at the surface of the earth would, in this case, be long-continued and attended with gradually expiring orogenic movements—all the more effective as occurring when the ocean floor had recovered much of its original strength and rigidity.

Eclogite is a rare substance at the surface of the earth. Its origin has been ascribed to extreme dynamo-metamorphism of gabbroid rocks. Its radioactivity has not as yet been specially investigated, but there is no reason to believe that it differs from that of gabbros, dolerites and basalts. J. Joly.

Trinity College, Dublin,
April 22.

The Source of Stellar Energy.

Many besides astronomers will have received pleasure from reading Prof. Eddington's lecture which appears in Nature of May 1, but I doubt whether mathematicians, physicists or chemists will be prepared to accept his proposed means of escape from the difficulties which beset his theories. He considers (in spite of mathematical proof to the contrary) that a star built on the uranium model—built, that is, of matter in which the generation of energy proceeds spontaneously without regard to changes of temperature and density—would be unstable. He then proposes to secure stability by supposing the star to be built on what may well be described as the gunpowder model: "To save the star we must suppose that the increase of temperature and density . . . causes an increase in E," E being the rate at which the star generates energy.

This seems to be a step from an imaginary frying-pan into a real fire, if the uranium star were unstable, surely the gunpowder star would be doubly so. Any increase of temperature resulting from a small disturbance would cause more energy to be generated, thus heating the star still further, producing still more energy, and so on indefinitely. This is what is meant by instability. To Prof. Eddington's dramatic question, "Can we suppose that energy issues freely from matter at 40,000,000° as steam issues from water at 100°?" the only possible answer seems to be a prosaic "No." When steam issues from water at 100° there is a positive 'latent heat' of transformation of about 536 cal. per gm. This regulates the issue of steam; 1 gm. issues from the water for each 536 calories of heat supplied to the water. If the latent heat had the negative value of − 536 cal.

per gm, no steady supply of heat would be needed, and we could evaporate a whole ocean by dropping in a lighted cigarette Now the transformation of matter into radiation has a huge negative latent heat equal to $-C^2/J$ or $-2{\cdot}15 \times 10^{13}$, and if the heat set free by generation of energy itself causes more generation of energy, we at once have a highly unstable state. In the case imagined by Prof. Eddington, as soon as the centre of a star reached 40,000,000° the heat generated would raise the neighbouring parts to 40,000,000°; these would generate more heat, and so on, the high temperature spreading explosively through the star. The true analogy would not be the issue of steam from water but the explosion of a magazine of gunpowder. The whole question is of course one for exact mathematical treatment. In an investigation which Prof. Eddington does not mention (*Mon. Not R A S.*, October 1925) I have shown that the uranium star would be stable and the gunpowder star unstable. The investigation goes further than this, and shows that considerations of stability practically limit us to the uranium model.

Although the central temperature of most stars is near to 40,000,000°, that of some of the brightest stars in the sky is as low as one or two million degrees (*e.g.* Antares, Betelgeux). This seems to negative the idea that a temperature of 40,000,000° is associated with any special generation of energy. Apart from all theories, the astronomical fact which requires explanation is that 40,000,000° appears to be a sort of upper limit, never exceeded by stellar matter, and that the central temperatures of most of the stars are fairly near to this limit. I suppose 95 per cent. of visible stars have central temperatures between 24 and 36 million degrees, although nothing can be said as to dark stars. My own view is that for some reason not yet fully explained, the transformation of matter into energy is inhibited somewhat abruptly at about this temperature, so that most stars balance their generation and expenditure of energy by taking up a temperature within the range mentioned. It is just within this range that ordinary atomic nuclei become stripped bare of electrons, and this may explain the stoppage in the generation of energy; perhaps only bound electrons are liable to annihilation.

Prof. Eddington states very frankly the difficulties that he sees in his own theories (although I think there are many more than he sees). But by omitting all mention of the successes claimed by rival theories he conveys the impression that the whole problem is in a state of confusion and inconsistency. I consider the situation ought to be painted in far brighter colours. A lot of the confusion arises, I think, from Prof. Eddington repeatedly saying 'unstable' when he ought to say 'stable,' and vice versa. Incidentally he also says 'overstability' when he means plain everyday instability with a time-factor $e^{(\alpha \pm i\beta)t}$; this explains the difficulty he finds in steering his star "between the Scylla of instability and the Charybdis of overstability." Conditions of stability, rightly handled, lead inevitably to stars built on the uranium model, and this in turn leads, practically inevitably, to the view of stellar evolution I have recently put forward (*Mon. Not. R.A.S.*, October 1925, and NATURE, January 2, p. 18). This escapes the difficulties which trouble Prof. Eddington, and seems so far to agree well with observation.

As Prof. Eddington raises the question of the origin of the idea of annihilation of matter as a source of sub-atomic energy, may I be permitted to add that the first mention I can find of it occurs in a letter by myself in NATURE (vol 70, p. 101, June 2, 1904) in pre-relativity days, in which I considered the possibility of there being "conservation neither of mass nor of material energy" but "an increase of material energy at the expense of the destruction of a certain amount of matter." The earliest reference I can find to it in Prof Eddington's writings also occurs in a letter to NATURE (vol. 99, p. 445, August 2, 1917), thirteen years later, in which he says the idea was suggested by me.

J. H. JEANS.

May 1.

The Drop-weight Method for the Determination of Surface Tension and the Weight of the Ideal Drop.

FOR nearly fifty years certain errors, which concern the weight of the maximum drop of liquid which will remain hanging from the lower circular face of a vertical cylinder and that of the drop which falls, have been present in the literature without adequate correction. It is true that during this period, and even earlier, correct treatments of the subject have appeared, but without the effect of diminishing the popularity of the errors. Unfortunately, the most prominent of these, that the weight of the drop which falls is equal to a constant multiplied by the circumference of the tip, is still given support by the statement of prominent text-books that it is sufficiently accurate for practical purposes, even although—but this they do not state—errors of so much as 60 per cent. may be involved.

It is not the purpose of this letter to discuss such an apparent blunder, but to consider certain fallacies which are even more objectionable because they are much more insidious. One of these in particular has been given such a marked recrudescence that Harkins and Brown have been severely criticised in NATURE, the *Philosophical Magazine*, and the *Journal of the Chemical Society*, for their failure to subscribe to the error, even although their paper on this subject (*J. Am. Chem. Soc.*, 41, 499, 1919) was written several years before its recent vigorous revival, and they were therefore entirely unaware that it would so soon become the vogue of the period.

Harkins and Brown introduced the conception of the weight of the *ideal drop* as equal to $2\pi r\gamma$ or the circumference of the tip multiplied by the surface tension ($c\gamma$). It happens that this is just the weight of liquid upheld by the surface tension in a capillary tube, but the choice of this value was due to two reasons. First, this is the weight given by the most complete theory concerning the form of drops, that of Lohnstein, for either the maximum drop which will hang or the drop which falls from an infinitesimal tip. Secondly, it is the value approached, as the tips become smaller, by the *actual weight* of the falling as well as of the hanging drop, as shown by the data of Harkins and Brown, together with a single point of Ollivier, and the work of others.

Notwithstanding the above facts, Iredale (*Phil. Mag.*, 45, 1088, 1923) asserts that the weight of the ideal drop is not $2\pi r\gamma$, but is only half this, or $\pi r\gamma$. Upon the basis of this assertion he intimates that the simple and exact method for the calculation of the surface tension from the weight of the falling drop as given by Harkins and Brown should be supplanted by his method, one which is in fact not entirely correct, and is in addition indirect, cumbersome, and involved, since it requires eight arithmetical operations to give a partly erroneous result in place of the four essential to our exact method. Also the most fundamental operation involved is taken directly from our work, and the data used are wholly those of Harkins and Brown.

Iredale gives as his reason for the choice of $\pi r\gamma$ the statement that in 1881 Worthington obtained this as the value of the weight of a drop which has a vertical contact with the tip. While it is true that Worthington did obtain this value, he did so only by neglecting a term which is fundamentally important in the theory of the form of hanging drops. Only two pages earlier Worthington includes this term, but in an endeavour to correct a fancied error attributed to Quincke, he neglects it. Thus he obtains the equation for the weight (W) of the drop as $W=2\pi r\gamma - \pi r^2\gamma/r = \pi r\gamma$ in which r is the radius of the tip, and also the radius of curvature of the drop in the plane of contact, only by neglecting $1/s$, the curvature in the meridian. That Worthington used the conception of curvature in a dual sense was pointed out to the writer by Dr. A. C. Lunn, professor of applied mathematics in the University of Chicago. The correct equation is, obviously, $W=2\pi r\gamma - \pi r^2\gamma\left(\frac{1}{r}+\frac{1}{s}\right)$, which does *not* give $\pi r\gamma$. To obtain vertical contact the tip must be very small (the more exact condition is that r/a shall be very small) *in which case* s has a sign opposite that of r, and furthermore is nearly equal to r in absolute magnitude, so the term $1/r+1/s$ is either very small or else equal to zero. For this reason the weight of the maximum hanging drop approaches $2\pi r\gamma$, and not $\pi r\gamma$, as the radius of the tip becomes extremely small.

It may be mentioned also that the equation $K^2=\gamma_1\rho_2/\gamma_2\rho_1$ used by Iredale to calculate surface tension (ρ = density) is incorrect from the theoretical point of view, and, in general, does not give such exact results as the theoretically correct form, equivalent to $K^2=\gamma_1\rho_2 g_2/\gamma_2\rho_2 g_1$, used by Harkins and Brown, even although he uses our data to obtain the values of K^2.

Thus Iredale's criticisms of the methods of calculation used by Harkins and Brown are wholly the result of his own errors. Since, however, his experimental work seems to be good, and he makes no application of the relation of $W=\pi r\gamma$, and since the error actually involved in the equation which he uses to apply the data of Harkins and Brown obtained in Chicago in his calculations, where g is different, happens to be small in its effect upon his own results, the present letter need not and would not have been written if Rideal and his associates had not espoused the fallacies and used them as the basis of reiterated criticisms in various journals. Thus, in reviewing Taylor's "Treatise of Physical Chemistry" in NATURE of February 28, 1925, Rideal states: "It is a pity that the erroneous conceptions concerning the determination of the surface tension of solutions by the drop-weight method are finding a place in standard text-books. Harkins' extension of Lohnstein's work on this subject might well be replaced by that of Iredale in a future edition." The peculiar nature of this criticism may best be realised when it is learned that the treatise to which the review relates does not contain any statement which presents the writer's "extension of Lohnstein's work." It does give, without previous reference to Lohnstein or myself, the opinion of the contributor to the 'Treatise" that "the surface tension is therefore equal to a constant times the weight of the drop where this constant has to be evaluated. This has been done by Harkins." The reference appended is to a preliminary paper printed three years before that of Harkins and Brown.

In an article in another journal, Dr. T. F. Young and I expect to give a more extensive treatment of the relations mentioned in the present letter, since sufficient space is not available here for a discussion of all of the factors involved

WILLIAM D. HARKINS.

The Disappearance of the Crystalline Style.

JUDGING by his letter in NATURE for April 10, p. 518, I do not think that Mr. Berkeley quite understands my theory as to the cause of the dissolution of the crystalline style, or the reasons why I am unable to agree with his opinion that the disappearance of the style in molluscs kept under anaerobic conditions may be, in part, "a direct response to the lack of oxygen."

Mr Berkeley is to be congratulated on his discovery (*Journ. Exp. Zool.*, vol. 37, p. 477) of the presence of an oxidase, possibly accompanied by an oxidising agent, in the substance of the style. I have been able to confirm his findings, as I have found an oxidase in the styles of all the lamellibranchs which I have examined, and I am at present carrying out further experiments on the subject with the style of *Ostrea edulis*. At the same time, Mr. Berkeley appears to me to make unwarranted assumptions when he endeavours on the basis of this discovery to account for the dissolution of the style.

I have shown (*Journ. Mar. Biol. Ass.*, vol. 13, p. 938), and have since confirmed in further experiments, an account of which will shortly be published in the same journal, that the style dissolves rapidly in water which is alkaline or slightly acid, but that at a certain critical pH (which varies according to the species but is usually in the region of 4·0, and probably represents the isoelectric point of the globulin of which the mass of the style is composed) it ceases to be dissolved or is dissolved extremely slowly. Since the fluid in the stomach always has a pH above this critical point (in spite of the fact that, as a result of the dissolution in it of the acid style substance, the pH of the stomach is invariably lower than that of any other region of the gut), it follows that the head of the style which projects into the stomach will be dissolved away—quite irrespective of the oxygen demands—while at the same time fresh material is being secreted in the style-sac behind. Under normal conditions, therefore, the style is only maintained as a result of a balance between the rate of its secretion and the rate of its dissolution. Mr. Berkeley does not seem to grasp the essentially physical nature of the dissolution, since he refers to the "consumption of the style substance for digestive purposes."

When a mollusc possessing a style is placed under adverse conditions, details of which are given in my paper, the style disappears—*but only in those animals in which the style lies in a groove in free communication with the gut.* In animals such as *Mya arenaria*, on the other hand, in which the style lies in a separate cæcum, only the *head* of the style is dissolved away even though the animals are kept out of water for *fourteen days*. Surely it is not unreasonable to suppose that the balance between rate of secretion and the rate of dissolution has been disturbed: the vital activities of the animals have been reduced and so secretion lowered. But dissolution still proceeds at the usual rate, and as a result the style will be dissolved except when it lies in a separate cæcum, when only the head can be dissolved, the remainder being sheltered from the action of the dissolving fluid. Mr. Berkeley criticises my experiments on the ground that they all resulted in the animals being kept under anaerobic conditions, but, as Dr. Orton (*Fishery Investigations*, Ser. 2, vol. 6, No. 3, p. 54) has stated to be the case in *Ostrea edulis* and as I have found in *Mytilus edulis*—both lamellibranchs with the style in free communication with the gut—the style is often absent in animals which are in poor condition even though the water is well aerated.

The style is re-formed when animals are replaced under normal conditions, and the presence of food is *not* essential for this process as the work of recent investigators has shown. Mr. Berkeley considers this evidence in favour of his theory, since the style is regenerated by aeration alone. But I fail to see that it invalidates my theory, since in these circumstances the vital activities of the animals will be restored—even though they are starved, for lamellibranchs can undergo months of starvation and be still perfectly healthy at the end—and secretion of the style substance will be increased until it resumes its normal dimensions, and so the usual balance between the rate of production of the style and the rate of dissolution will be regained.

Again, and this is a point to which Mr. Berkeley does not refer, if his theory is correct there should be some correlation between the size of the style and the habitat of the animal. If an animal possessing a style is normally exposed to anaerobic conditions, one would expect that it would have a larger style than one which never suffered from lack of oxygen. There is, however, no such correlation, a fact to which I directed attention in my paper, while exactly the same point was raised by Prof. T. C. Nelson (*Biol. Bull.*, vol. 49, p. 86) in a review of recent work on the crystalline style published about the same time as my own paper, both of us being in complete ignorance of the work of the other. He compares the habitat of *Pisidium idahoense*, which lives in the mud at the bottom of Lake Mendota, Wisconsin, " where for two-thirds of the year the water may be completely devoid of oxygen," with that of Mactra, which lives " in or close to the breaker line along sandy coasts, where the water at all seasons of the year is saturated with oxygen." Yet the style of Pisidium is no larger than that of related species living in well-aerated water, while the styles of all species of Mactra are exceptionally firm and large.

Like Prof. Nelson, I find myself unable to accept Mr. Berkeley's views as to the cause of the disappearance of the style, nor do I agree with him that the matter should be considered *sub judice*; since I consider that my experiments demonstrate clearly that the dissolution of the style is a purely physical process and not in any way, in the words of Mr. Berkeley, " an expression of an effort on the part of the animal to offset the strain on its vital activity induced by anaerobiosis." C. M. YONGE.

The Laboratory, Citadel Hill,
Plymouth, April 20.

Ultramicroscopic Organisms of Filterable Viruses.

IT appears to me that the fundamental significance (apart from its medical importance) of Mr. J. E. Barnard's[1] observations on the ultramicroscopic organisms known as filterable viruses has not been sufficiently recognised by biologists. These observations show the existence of a group of organisms as different from bacteria as bacteria are from yeasts or molds. The term cell cannot properly, in my opinion, be applied to them. Mr. Barnard's observations and photographs with ultra-violet light, particularly of the organism causing bovine pleuropneumonia, show minute hollow vesicles devoid of nucleus or of a cell wall in any proper sense. The ' wall ' of the vesicle is evidently the living material of the organism, and it appears justifiable to apply to its substance the term protoplasm. But its methods of reproduction show that there can be little differentiation of the presumably protein materials composing this ' wall.'

These organisms appear to multiply in two ways: (1) by the appearance of minute papillæ on the surface of the vesicles. These are later attached to the vesicle only by threads, and they finally grow into new vesicles. This process bears some resemblance to the budding of yeast cells, but there are fundamental differences. (2) A vesicle may elongate into a flattened hollow structure which then breaks up into a row or group of particles like the papillæ, having the same property of growing into vesicles. This process might perhaps be compared with gonidia formation in such bacteria as Crenothrix. It was also found that the vesicle stage could be separated from the particle stage by filtration through a collodion membrane.

This group of ultramicroscopic organisms in its extreme simplicity and methods of reproduction brings us a distinct step nearer the inorganic. They are not strictly cells in the sense in which that term has hitherto been used by biologists. We appear to have here organisms reduced to their lowest terms, undifferentiated particles of protoplasmic material which can grow into hollow vesicles reproducing by budding and fragmentation. It becomes a question whether any organisms could be yet smaller and still show the essential phenomena of life. I suggest for these organisms the name *Protonta*, to contrast them with the plant and animal unicells which Haeckel grouped together as the Protista. It is quite possible that a world of organisms of this class exists, which are neither plants nor animals nor cells, and are as extensive and ubiquitous as the Protists. We have no present means of recognising their existence except in the case of those which are, like the virus diseases, parasitic in animals and plants.

That these organisms stand distinctly nearer the inorganic than bacteria is obvious. Investigations of the so-called d'Herelle phenomenon and of enzymes by similar methods, by showing the condition of aggregation of these bodies, will help to indicate just how wide is the gap which still separates such bodies from the strictly inorganic.

My apology for intruding into this field must be that it is one in which I have long been interested.

R. R. GATES.

King's College, Strand, London, W.C.2.

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[1] "The Microscopical Examination of Filterable Viruses," *Lancet*, 1925, pp. 117-123.

Half-integral Vibrational Quantum Numbers in the Magnesium Hydride Bands.

THE new quantum mechanics predicts[1] that both the rotational and vibrational quantum numbers in band spectra should have half-integral values. Numerous examples of half-integral rotational quantum numbers have been reported in recent work, but as yet only one case where the evidence is in favour of half-integral vibrational quantum numbers has been recorded. Mulliken has shown[2] that the magnitude of the isotope effect in the BO bands is such as to argue for the adoption of half-vibrational quantum numbers. Indeed, accurate observations of isotope effects apparently constitute the only available method for getting evidence on this point.

P. Rudnick and the writer[3] have recently noted the presence of the approximately correct rotational isotope effect in the fundamental (λ5211) band of magnesium hydride. I have made some new calculations of our data with the object of deciding as to the applicability of half-vibrational quantum numbers to these bands, with the following result: Assuming half-integral values for n' and n'', the initial and final vibrational quantum numbers, with a minimum value $+\frac{1}{2}$, the band-origins of this system can be represented approximately by the equation

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[1] W. Heisenberg, *Zeit. f. Physik*, 33, 879, 1925.
[2] R. S. Mulliken, *Phys. Review*, 25, 279, 1925.
[3] *Astro. Journal*, 63, 20, 1926.

$$\nu = \left.\begin{matrix}19217\\19224\end{matrix}\right\} + (1603{\cdot}5n' - 34{\cdot}75n'^2) - (1493{\cdot}5n'' - 31{\cdot}25n''^2).$$

Placing the values of these coefficients in the equation for the vibrational isotopic displacement as given by Mulliken,[4] and taking the isotopes of magnesium to be 24, 25, and 26, one readily computes that for the $\frac{1}{2} \longrightarrow \frac{1}{2}$ band,

$$\nu^n_{25} - \nu^n_{24} = -0{\cdot}042 \text{ cm.}^{-1},$$

$$\nu^n_{26} - \nu^n_{24} = -0{\cdot}082 \text{ cm.}^{-1}.$$

That is, the faint pairs of lines due to the less abundant isotopes 25 and 26 found on the low-frequency side of each strong doublet in the Q and R branches should be displaced by these amounts in addition to the (much larger) rotational isotopic displacement (also to the red). As a matter of fact, of 27 recorded pairs of Mg (26) lines, every one is displaced farther from the Mg (24) pair than is allowable as a pure rotational isotopic effect. The average increased displacement is $-0{\cdot}073$ cm.$^{-1}$, which is in good agreement with the theoretical value $-0{\cdot}082$ cm.$^{-1}$, considering the smallness of the shift. For the Mg (25) pairs the agreement is not quite so satisfactory (the measurements of the lines being less accurate), the observed average increased displacement, however, being fair, $-0{\cdot}029$ cm.$^{-1}$, as opposed to $-0{\cdot}042$ cm.$^{-1}$, as given by the theory. It is to be concluded, then, from these results that the vibrational quantum numbers in this band system must be given half-integral values.

WILLIAM W. WATSON.

Ryerson Physical Laboratory,
University of Chicago.
April 3.

Origin of Yolk in the Eggs of Spiders.

IN a remarkable paper on the oocyte of *Pholcus phalangiodes* published in the last century (*Arch. de Biol.*, tome 15, 1898), Van Bambeke described a uxta-nuclear ring, the pallial layer or the pallial substance (see Wilson's "The Cell," third edition, p. 340), which with the growth of the oocyte separates rom the nucleus, and, after fragmenting finely hroughout the cytoplasm directly, gives rise to fatty leutoplasm. He also described ordinary yolk spheres which are albuminous in nature and arise independntly in the cytoplasm.

During the last winter I have been working on the ggs of the common spider in Patiala, and I have seen very much impressed by the remarkable acuracy of Van Bambeke's account in spite of the erious shortcomings of the technique (so far as the xation of lipoids is concerned) in vogue in his time. have shown that the pallial layer of Van Bambeke eally consists of granular mitochondria, embedded n which are the Golgi elements in the form of rings r crescents. Indeed, Van Bambeke figures granules nd rings in his pallial substance, but naturally he as not able to identify them. Mitochondria, of ourse, had been discovered earlier, but the Golgi pparatus was not yet known.

I strongly confirm Van Bambeke's statement that here are two kinds of yolk in the egg of spiders—tty and albuminous. Further, his statement that e albuminous yolk arises *de novo*, and the fatty olk is derived from the pallial substance, is correct. Now the pallial substance consists of mitochondria and the Golgi elements. Is the fatty yolk derived from the mitochondria or from the Golgi elements? I have proved that the Golgi elements are directly metamorphosed into the fatty yolk, as in Lithobius (Nath, *Proc. Camb. Phil. Soc. Biol. Sci.*, 1924), *Helix aspersa* (Brambell, *Brit. Jour. Expt. Biol.*, vol. 1), Saccocirrus (Gatenby, *Quart. Jour. Micr. Sci.*, 1922), Patella (Ludford, *J.R.M.S.*, 1918), and possibly in Palamnaeus (Nath, *Proc. Roy. Soc.*, London, 1925). The mitochondria remain unchanged. A full account will be published later.

VISHWA NATH.

Bhupindra Research Laboratory,
Mohindra College, Patiala, India.
April 7.

On the Occurrence of 2n+1 and other Chromosomal Mutants.

CHROMOSOMAL mutants with one extra chromosome (or the corresponding $n+1$ gametes) have been found in Oenothera, Datura, Matthiola, Nicotiana, Uvularia, and perhaps Mirabilis. It seems probable that they could be found in many other plants, if investigation *ad hoc* were made, either as somatic or gametic mutations. Such $2n+1$ offspring have also been found fairly often in Drosophila, and doubtless occur in other animals.

We have now a tolerably rapid method for counting the chromosomes of mammals, by the use of pieces of the amnion, stained with hæmatoxylin, and mounted in balsam. It is possible that portions of this membrane may be examined directly in iron-acetocarmine. In this case the chromosomal number of individual mammals could often be rapidly determined at birth. It would be of especial interest to know whether $2n+1$ forms occur in man. There should be, of course, 24 possible $2n+1$ forms in Homo (disregarding the Y chromosome), which is the same number as in tobacco. The possible occurrence of haploids, triploids, or tetraploids in mammals (as in several plants and in Drosophila) is also of interest, since $2n$ gametes have been seen (Painter) in Homo It is hoped that investigations may be made on this point in mice, rats, or guinea-pigs.

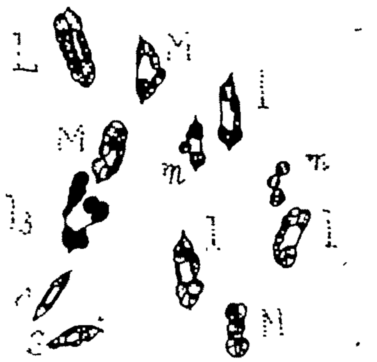

FIG. 1.—Group of chromosomes of $2n+1$ Datura mutant with an extra No. III. chromosome. Metaphase of reduction division. Camera drawing showing one trivalent and eleven bivalents.

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ERRATA.—"The Problem of X-Ray Line Intensities": NATURE of May 1, p. 622. Paragraph 3, line 4, for *0·030* read *0·093*; line 12; for 80·04 cm. read 8 04 cm.

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[4] *Phys. Review*, 25, 127, 1925.

The Growth of Crystals.[1]

By Prof. C. H. Desch, F.R.S.

GEOMETRICAL crystallography, which has reached a state of such remarkable perfection since its beginnings a century and a half ago, is concerned with the conditions of symmetry in crystals and with their possible faces, but it attaches little importance to the relative development of those faces, so that variations of habit, of such interest to the mineralogist, are mostly ignored. Since crystals of strikingly different habit, such as the many varieties of calcite, may all be derived from the same primitive crystal, their peculiarities must be due to variations in the conditions during growth, and this fact gives to the study of the growth of crystals a special importance.

A simple crystal immersed in a solution of the right degree of supersaturation may continue to grow whilst retaining its original shape unimpaired, as in the perfect octahedra of the alums which have been prepared by some manufacturing firms. Such crystals may grow to a large size without change of shape; and when an octahedron of chrome alum, for example, is allowed to grow in a solution of the isomorphous common alum, the regularity of growth is obvious from the uniformity of the colourless sheath enveloping the coloured nucleus. The increase in size has been brought about by the deposition of a uniform layer of new material on each face. On the other hand, faces may disappear or new faces may make their appearance in the course of growth, and an explanation has to be sought in the external conditions and in the internal structure of the crystal, both factors being concerned in producing the result.

It has long been known, certainly since the eighteenth century, that the presence of small quantities of foreign matter will sometimes produce a change of crystalline form. Common salt, which usually crystallises in cubes, forms octahedra if grown in a solution containing urea. When the quantity of urea is small, crystals with the faces of both the cube and the octahedron are produced. The crystals of organic compounds often vary very greatly according to the solvent which has been used. Such facts as these give the first clue to the problem of growth.

THE SPACE LATTICE IN CRYSTALLOGRAPHY.

The use of X-rays in the study of crystal structure has placed crystallography on an entirely new footing. All modern studies of crystals start from the idea of the space lattice. The atoms, whether occurring singly or grouped to form molecules, are so arranged in space that a single unit is exactly repeated at regular intervals in three dimensions. Through such an assemblage planes may be drawn in any direction. Certain planes so drawn will contain a greater number of atoms in a given area than any planes drawn in a different direction, and it is these closely packed planes which play the principal part in crystal structure. Moreover, in crystals in which the atoms are of more than one kind, different planes may contain the atoms in different relative proportions, so that they may be assumed not to be chemically identical. Any plane may be imagined as a possible face of the crystal, although only a few of them are realisable in practice.

The several planes must have different chemical properties. This follows from our conception of the space lattice. The forces which hold the atoms in position are electrical in character, and depend on the number and arrangement of the electrons in each atom. The chemical behaviour is dependent on the same conditions, and the chemical properties of a crystalline surface must vary with the grouping of the atoms within it. What chemists often call residual affinity must vary with the denseness of packing of the atoms in a plane, so that each set of similar faces must have its own chemical characteristics. This supposition is confirmed by the action of chemical agents on crystals. In the etching of metals by acids it is easily seen that the reagent penetrates more readily along certain planes than in any other direction, as clear facets, of cubes or octahedra in most instances, make their appearance and give the characteristic lustre to the etched surface.

THE PROCESS OF CRYSTAL GROWTH.

It has been shown by Johnsen, Gross, and others that the faces which survive during growth are those which have the lowest velocity of growth in a normal direction, and that these are in general the most closely packed planes. More openly packed planes have a higher velocity of growth, but their relative area diminishes as the crystal increases in size, and they ultimately disappear. The experiments of Nacken on salol and benzophenone are instructive. By attaching a small crystal of salol to a copper hemisphere immersed in the molten substance maintained at a constant temperature, and withdrawing heat by cooling a copper rod attached to the hemisphere, the rate of cooling could be varied; and it was found that when this was very slow the liberation of latent heat by the solidification of the salol and its removal by conduction kep pace with one another, and the surface of the growing crystal was spherical or nearly so, being determined only by the thermal conductivity, which varies only slightly in the direction of the different crystallographic axes. As the rate of cooling is increased, the growth perpendicular to certain directions fails to keep pac with the rest, and faces having a low velocity of perpendicular growth begin to make their appearance at first with oval outlines. As the crystal increases in size, the area of such faces increase until their boundaries meet, and the crystal at las assumes its typical form, with plane faces and straight edges.

The experiments of Volmer and others on the formation of crystals of zinc and mercury in an evacuated vessel, by the impact of a stream of molecules o the metal on a plane surface, have thrown much ligh on the process. Nuclei are at first formed, and thos grow which have the basal plane (the crystals being hexagonal) perpendicular to the direction of the strean This plane has the lowest velocity of growth in direction normal to itself. With mercury at −60° (

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[1] Substance of two lectures delivered at the Royal Institution on March 16 and 23.

thin leaflets result, the thickness of which is only one ten-thousandth of the diameter. A quantitative interpretation of these experiments, together with those of Marcelin, which proved growth to be a discontinuous process, occurring by the formation of successive thin sheets, leads to the conclusion that atoms or molecules are first adsorbed as a layer of unit thickness, the atoms or molecules in which have a certain freedom of movement. In the course of such movement, groupings which may be regarded as two-dimensional crystal nuclei may arise, and the whole layer then assumes an orderly arrangement, in conformity with the underlying space lattice.

Since adsorption plays so large a part in growth it is not surprising that an alteration of habit may be produced by the presence of impurities. The observations of Gaubert on lead nitrate are particularly instructive. This salt separates from water in octahedra, but when methylene blue is added cubic faces appear, these faces being stained blue while the octahedral faces remain colourless. As the quantity of the dye is increased, the crystals become completely cubic, with blue faces. Evidently adsorption of the colouring matter by the cube face has lessened its rate of growth, so that it survives at the expense of the more rapidly growing octahedral face. It is probable that differences of habit in naturally occurring minerals are largely due to the influence of small quantities of foreign matter, but a very small quantity may suffice, so that the impurity responsible for the result may not have been detected in the course of an analysis.

Well-developed crystals are usually formed by comparatively slow growth, so that as material is withdrawn from the solution, or as heat is given out by the solidification of a melt, there is ample time for readjustment. Miers has shown that the solution in immediate contact with the growing face of a crystal of a salt is actually denser than the bulk of the solution, suggesting that the dissolved molecules undergo a preliminary rearrangement in the liquid before separation as a solid. For this view there is some evidence, notably from the fact, observed by Nasini and others, that solutions which are undercooled through the freezing-point show small discontinuities in properties, although no solid separates. It will be of considerable interest to examine this point by means of the X-ray method.

On the other hand, when growth is very rapid, the supply of material by diffusion may not keep pace with it, and the conditions are disturbed. Simple geometrical considerations show that the sharp angles of the crystal are more favourably placed for the reception of material by diffusion than the middle parts of faces; so that growth occurs at the angles by preference. The effect is cumulative, so that the crystal assumes a star shape, which in course of time undergoes branching, the process being repeated at each branch. This is the origin of dendritic crystals, which are so common in Nature. They are most easily obtained by allowing crystallisation to take place rapidly, as when a solution of a salt is evaporated quickly on a glass slide. The internal symmetry of the crystal is not destroyed, and most such crystals may be regarded as parallel growths, one axis being usually favoured. Thus native copper branches in the direction of the octahedral axes, whilst common salt forms growths parallel with the trigonal axes.

The process of diffusion may be hindered, and dendritic growth encouraged, by making the solution more viscous, as by adding gum. In highly viscous materials, such as glasses, slags, and pitchstones, very beautiful dendritic growths are frequently present. The 'trees' formed by the electrolysis of solutions of metallic salts have a similar structure.

PERIODIC CRYSTALLISATION.

Periodic crystallisation is an interesting phenomenon, which again has a bearing on the origin of naturally occurring mineral structures. It was observed more than seventy years ago by Brewster in ancient glass which had undergone a process of decay. It may arise from several different causes in different substances.

The effect is very simply observed in molten salol. When a thin layer is melted on a slide and allowed to cool, slender needles are seen to radiate from each centre. The advancing point of each needle withdraws material from the liquid, and a gap is left, the molten salol standing up as a wall in front of the crystal edge. Owing to its viscosity, an appreciable time is required for the liquid to flow until it is again in contact with the crystal, when growth is resumed. This process is repeated, so that the advance of the needle is intermittent, and the crystal when complete is marked by transverse lines indicating the stages of growth. The process may be followed under the microscope with ease.

Some salts crystallise from water with a very definite periodicity, the best example being potassium dichromate, a thin layer of a solution of which, if rapidly evaporated, will yield concentric rings of minute crystals with very regular intervals. The effect is here no doubt one of supersaturation, the solution being impoverished by the separation of one ring of crystals, so that the process is interrupted until the right concentration is again reached by diffusion, and so on. Similar structures are seen in glazes on porcelain and, although more rarely, in slags. They are closely connected with the phenomenon of periodic precipitation in jellies, the formation of Liesegang's rings.

The study of periodic crystallisation throws light on some natural structures, especially of agates, which are in all probability formed by the periodic crystallisation of silica from the gelatinous contents of a cavity in a rock. Ruskin maintained that the banding in agates was due, not to periodic infiltration of a liquid, but to segregation, and his view is confirmed by modern work. In particular, the so-called canals, which have been supposed to represent the passages by which liquid entered and left the cavity, are seen, by laboratory experiments on periodic crystallisation, to be merely geometrical effects produced by the meeting of different systems of advancing bands.

Dendritic and periodic crystallisation depend on more complex causes than change of habit, and are correspondingly more difficult to study in a quantitative manner; but there can be little doubt that the examination of the chemical properties of the several planes in crystals will throw much light on these as on other problems of crystallisation.

New Arctic Expeditions.

THREE expeditions, each aiming to cross by air the unknown regions in the heart of the Arctic Ocean, have been or are at work in the north. Capt. R. Amundsen, profiting from his experience of last year, when he found his range of flight seriously limited by lack of petrol, substituted a semi-rigid Italian airship for an aeroplane. The *Norge*, under the command of its designer, Col. U. Nobile, and piloted by Major G. F. Scott, reached Pulham from Rome on April 11, Oslo on April 14, Leningrad on April 15, and King's Bay, Spitsbergen, early in May. The polar flight took place on May 11-13, the *Norge* passing over the Pole at 2 A.M. on May 12. On her flight from Rome to Pulham the *Norge* covered 1400 miles at an average speed of 47 miles an hour. Only two of the three 250 horse-power engines were used, each being rested in turn. From Spitsbergen to Point Barrow in Alaska via the Pole is 1800 miles, and in favourable weather Capt. Amundsen appears to have crossed in 45 hours.

The *Norge* descended safely at Teller, 650 miles from Point Barrow, having accomplished a total distance of 3393 miles from Spitsbergen in 72 hours. Damage was caused to the balloon fabric by fragments of ice, due to condensing moisture, being thrown violently from the propellers. Capt. Amundsen reports that lack of sleep and freezing of food supplies were the only discomforts on the journey. Thin ice and some open water were seen at the Pole, where the *Norge* descended to within 600 ft. of the sea.

The *Norge's* fuel capacity is seven tons, which, at a speed of 50 miles an hour, gives her a range of 3000 miles, in calm air, or about 60 hours. Her gas capacity of 660,000 cubic feet is about a third that of R. 33. Her length is 348 ft., and her maximum speed is 60 miles per hour. Wireless communication was maintained throughout the flight. The crew numbered 15, including Capt. Amundsen, Col. U. Nobile, and Mr. L. Ellsworth. Lieut. Larsen was the pilot.

An American expedition under Lieut.-Commander R. E. Byrd, U.S. Navy, with Mr. F. Bennett as pilot, is also at King's Bay with a three-engined Fokker monoplane. The original plans included six flights. According to the *Times*, the first was to be one of 400 miles from Spitsbergen to Peary Land, North Greenland, to land oil and provisions. On returning to the base the aeroplane was to make a second journey to Peary Land with more supplies, and then leave on an 850 miles' flight to the Pole and back. On May 9, Lieut.-Comdr. Byrd left on a flight to the north and returned in 15½ hours, announcing that he had reached the Pole. Confirmation is still lacking.

The third flying expedition is the Detroit Arctic expedition under Mr. G. H. Wilkins, who has arrived at Point Barrow with two Fokker aeroplanes. With Mr. C. B. Eielson as pilot, Mr. Wilkins proposes to fly northward over the heart of the unexplored Beaufort Sea. If no land is discovered he hopes to continue across the Pole to Spitsbergen. On the other hand, if land is found, the aeroplane will return to Point Barrow and both machines will go north and attempt to make a base on the new land, whence one aeroplane will continue to Spitsbergen. Mr. Wilkins, who gained his polar experience with Mr. Stefansson, proposes to adopt his former leader's precept; he will carry as much petrol as possible, and depend on seals for food if he is forced to descend. Near land this may prove possible, but Mr. Stefansson in 1914 crossed areas of the Beaufort Sea in which he saw no seals, and Capt. Amundsen last year reported only one seal at the place of his forced descent.

It is unlikely that any of these expeditions will report new land. Evidence of its existence in the unexplored parts of the Arctic Ocean is lacking, and the results of the recent expedition of the *Maud* supports this point of view. In any event, it is improbable that rapid flights across polar regions can achieve results of great scientific interest.

Less sensational, but more promising in results, are several expeditions to Greenland. Prof. W. H. Hobbs, of Michigan, is leading an expedition to study the glacial anticyclone. He proposes to sail in July for his main base at Holstenberg, a little north of the Arctic Circle on the west coast of Greenland, where the ice-free margin of the land is about 100 miles wide. Here in a sheltered valley the main base, with a hangar for two aeroplanes, will be established. A second station will be near the coast at a height of about 1000 metres, a third at about 2500 metres on the ice cap, and a fourth, well in the interior, in the area of calms and light winds which Prof. Hobbs believes to exist in the heart of the anticyclone. This last station will be visited frequently, but the other three will be inhabited, it is hoped, for fifteen months and will be in charge of Mr. P. Freuchen, the Danish explorer of Greenland. A snow motor and two aeroplanes will be used to establish the stations and main base connexions. There will also be wireless communication with Godthaab and with Dr. L. Koch's expedition on Scoresby Sound. Prof. Hobbs, who will return with many of his staff in October, has received the collaboration of Mr. V. Douglas, Dr. W. Koeltz, and Prof. H. T. Barnes. The expedition has the support of the U.S. Coast and Geodetic Survey and the U.S. Weather Bureau.

An expedition of seven members under Mr. J. M. Wordie is leaving Aberdeen in June for the east coast of Greenland. Mr. Wordie, who was foiled in his attempt to reach the coast in 1924, intends to make for Shannon Island, and, having got through the pack-ice, to make southward to Franz Josef fjord for geological work. The expedition will return at the end of the summer, but is carrying the necessary equipment and stores in case of a forced wintering, which, however, is improbable since in September the coast south of Scoresby Sound is relatively free from ice. Further south, Dr. L. Koch intends to continue his exploration of Greenland from a base on Scoresby Sound, where an Eskimo colony was founded last summer. Other colonies are to be founded in the same district on the site of former Eskimo settlements at Cape Stewart, Cape Hope, and Cape Tobin. The Field Museum of Chicago announces a collecting expedition under Dr. D. B. Macmillan to sail in July to Baffin Land and Ellesmere Land. Several other Arctic expeditions have been prepared for this summer, including a French attempt under Lieut. Sales northward from Spitsbergen in motor sledges, but their start is uncertain. R. N. Rudmose Brown.

News and Views.

The scheme proposed by Sir Frank Heath for the re-organisation of the Commonwealth Institute of Science and Industry has been tabled in the Australian House of Representatives. The outstanding aim in the scheme is to obtain the utmost co-operation of all the States with the Commonwealth in the formulation of advice through carefully selected men of responsible position and wide outlook, it being recognised that the vast distances of Australia and the wide range of its climates demand a degree of decentralisation much greater than is necessary or desirable in a smaller and more populous country. It is recommended that the purposes of the Institute be defined under three heads: (1) To provide for the training of young men and women in scientific research and for the encouragement of research workers who have already shown capacity for original work; (2) To take responsibility for conducting scientific investigations into problems of importance either (*a*) to the whole industrial activities of the Commonwealth, whether primary or secondary, or (*b*) to the interests of Australian consumers as a whole; (3) To encourage and assist under suitable conditions the solution of scientific problems of importance to particular States or groups of States, which, though urgent in themselves, do not affect the whole Dominion.

Three derivative functions for the Commonwealth Institute of Science and Industry are added to the main purposes set out in Sir Frank Heath's scheme for re-organisation: (*a*) To act as a clearing-house for information on scientific matters affecting the industries of the country; (*b*) To act as the principal and official means of *liaison* in scientific matters between the Governments of the Commonwealth and those of Great Britain and other parts of the British Empire; (*c*) To become, as it wins the confidence of the world of industry and science, the adviser of the Government on the scientific aspects of policy. It is proposed that the Institute be constituted a body corporate consisting of the Prime Minister for the time being and an advisory council of a chairman and eight members, under the title of the Department of Research in Science and Industry. The chairman and two members are to be appointed by the Governor-General and are to form an executive committee with very extensive powers. The other six members are to be the chairmen of State advisory committees. Each of the latter is to include two members nominated by the State Government from its scientific staff, two members of the State University nominated by the Australian National Research Council, and two representatives of the principal industries of the State.

It is suggested that the advisory council which is to constitute the body corporate of the Commonwealth Institute of Science and Industry should meet twice annually at equal six-monthly intervals. It may initiate proposals for research and must consider proposals sent to it by State committees. Between these meetings the executive committee may exercise all the powers of the council. The chief executive and accounting officer to the Institute will be appointed by the Governor-General and act as secretary to the advisory council. As member of his staff he will have in each State an officer who will be secretary of the State advisory committee. The responsibilities placed upon the executive committee of three will be continuous and important, though it is not proposed that its members should be full-time officers. Sir Frank Heath urges that in their selection the first test to be applied should be the certainty that their presence on the advisory council will bring prestige and public confidence to the work of the Institute. Taken as a whole, the proposals for general organisation and future operations follow, as closely as circumstances permit, the lines which have proved successful in the Department of Scientific and Industrial Research in Great Britain, and provision is made for developing the maximum possible co-operation between the British and Australian organisations.

The annual Halley Lecture of the University of Oxford was delivered on May 5 by Dr. G. M. B. Dobson, Lincoln College, University lecturer in meteorology, who took as his subject "The Uppermost Regions of the Earth's Atmosphere." The higher regions of the atmosphere were defined as having a lower limit of say 20 kilometres. Exploration of these tracts is difficult: something can be done by means of dirigibles and balloons: Goddard in America has suggested rockets, by which he hopes to obtain instrumental readings up to a height of two or three hundred kilometres. The amount of each gas present in the atmosphere seems to be fairly constant at moderate altitudes; above these, the large bulk of hydrogen emitted by volcanoes introduces a difference, which would make a difference in the pressure. Some information as to the higher regions can be gathered from the aurora borealis. The occurrence of this phenomenon shows some correspondence with the period (27 or 28 days) of the sun's rotation. Sunspots are often, but not always, present at the time of an auroral display. At the fine display of a few weeks ago there was no visible sunspot. The spectrum of the aurora shows the presence of nitrogen; there is also a characteristic bright line in the green, probably due to oxygen and helium bombarded by electromagnetic particles. A second source of information is the appearance of meteors, chiefly consisting of iron. These become visible at a height of from 30 to 160 kilometres. The temperature of the air, which falls at first, appears to rise again at heights above 120 kilometres. Observations of the trails of meteors enable us to estimate the direction of the wind at different heights. Yet another means of learning something of the constitution of the upper atmosphere is the phenomenon of 'luminous clouds.' These often resemble the 'northern lights,' but their spectrum is that of sunlight, and is without the bright green line characteristic of the aurora. They probably consist of dust from volcanoes, and not of water-vapour. The distribution of dust-clouds shows foci of intensity within areas of vacancy; this is analogous with the distribution of the sound of an explosion.

Air Vice-Marshal Sir W. Sefton Brancker gave some interesting information concerning air transport on the occasion of the fifth Gustave Canet Memorial Lecture which he delivered before the Junior Institution of Engineers on April 30. He said that in no case within Europe has air transport paid its way, it exists only by the grace of subsidies. The British company Imperial Airways has complete freedom in its policy, and, with its predecessors, has already carried more than 70,000 passengers across the Channel, with only four fatal accidents. The first British Empire air-link outside Europe is about to be established. Imperial Airways have accepted a contract to operate a fortnightly service between Cairo and Karachi via Baghdad, to commence on January 1, 1927. Four days are permitted for the voyage of 2500 miles, but it is proposed ultimately to perform the journey in thirty hours. The British Government has decided to go on with airship development, two big ships being at present on order. The present plan is to operate an experimental service to India, with a base at Karachi and a temporary calling-station at Ismailia. The most difficult problem which confronts air transport is the reduction of costs to render a Government subsidy unnecessary; the total cost of carriage by air is now about 5*s.* a ton-mile at 90 miles an hour. The predominant factors are overhead charges, operating costs, and revenue. Obsolescence and depreciation are usually estimated at 20 per cent. per annum, but that is not sufficient. Most of the existing machines ought to be replaced by all-metal craft fitted with air-cooled engines and provided with stability and economy devices. As regards engine maintenance, it was stated that about 60 per cent. of engine defects are due to the water system, valve breakage or distortion, or oil circulation. The development of the heavy oil engine for use in the air is going on steadily. The engine is appreciably heavier than the normal petrol engine, but shows considerable saving in weight of fuel burnt per horse-power.

In the course of a Chadwick Public Lecture delivered at Bangor on May 4, on "The Collection and Utilisation of Small Water Supplies for Rural Communities and Single Houses," Mr. Henry C. Adams said that the recovery and utilisation of underground waters is of comparatively recent origin. In the earliest ages streams and springs formed the only supply of water; to-day they still form the only supply for many thousands of the population in Great Britain, but they can no longer be regarded as essentially a pure or even a safe source of supply for potable purposes. The amount of water which may reasonably be required varies within wide limits. For cottage property 10 gal. per head per day is an ample allowance; indeed, when water has to be carried for use the consumption frequently does not exceed 8 gallons. When, however, a piped supply is afterwards laid on, consumption generally increases at once to about 15 gal. Natural filtration through a considerable depth of permeable strata will arrest the organic and bacterial impurities in the water, but in default of this, artificial filtration is the most practical and effective method to adopt. If space is limited it may be preferable to put down mechanical or rapid filters in place of sand filters. In 1914 the Ministry of Health reported that 285 million gallons of water a day was supplied in Great Britain for domestic purposes from underground sources, excluding springs. The nature of the source from which water is obtained changes as one traverses England. On the east, with its porous surface strata, surface supplies are generally unknown, saving for occasional springs here and there. In the Midlands, examples are found of water from all types of sources; while on the west coast, with its impermeable rocky surfaces, deep underground supplies are practically unknown and surface waters are used almost entirely.

Mr. P. Dunsheath gave an interesting lecture on "Science in the Cable Industry" to the Royal Society of Arts on March 3, which has recently been published in the Society's journal. The application of science to cable making is not entirely a modern innovation. More than sixty years ago Kelvin gave a theory of electrical transmission in the submarine cable. Generally speaking, the cable industry has flourished under the direction of practical men guided by masses of collected data rather than by scientific principles. Cable making has been an art rather than a science. During the last fifteen years, however, the introduction of high electric pressures has made it necessary for the designer and manufacturer to have both the highest technical skill available, and also the help of scientific men with a thorough knowledge of the latest theories. In the lecturer's opinion, cable manufacture offers to-day the widest and most promising field for scientific research. The problems are mainly in connexion with conductors and insulators, and their solution demands the highest mathematical and experimental skill. The British Electrical and Allied Industries Research Association and the National Physical Laboratory have done work which has been of the greatest commercial value to the industry, and the work of the individual researcher has been of equal importance. Cable of British manufacture has always been in the front rank in the markets of the world, and scientific research is being utilised to the full to enable it to keep that position.

The increasingly important part played by light in the modern treatment of disease is illustrated by the receipt recently of numbers of two journals devoted entirely to this subject. *Raggi Ultravioletti*, published at Milan, is a monthly review of ultra-violet therapy, which has now reached its second year of publication. It contains original articles on the treatment of diseases such as rickets and tuberculosis by means of light, short clinical notes on cases of interest and abstracts of current literature. Improvements in technique and medical news are also included. It should be of interest especially in bringing forward the Italian viewpoint on various diseases of world-wide distribution. The other publication received is *Modern Sunlight*, which has recently been published in London. This journal, while including a number of short scientific articles, is primarily devoted to supplying information on the subject of sunlight, natural or artificial, to the lay public. The important part which can be played by ultra-violet light in the treatment and cure of certain diseases may tend to an over-enthusiastic use of it in all kinds of conditions, with a certain amount of resulting disappointment. The fact, however, that these rays seem to play a part in the improvement of the general health of the body, suggests that they may usefully be combined with a specific treatment in a large number of diseases in which the general health has deteriorated. An appreciation of their uses and abuses on the part of the general public will avoid the dangers of over-enthusiasm and lead to their more ready use in conditions in which they are definitely indicated.

WE welcome the appearance of the first number (January 1926) of the *Indian Journal of Psychology*, a quarterly publication and the official organ of the Indian Psychological Association. The article of most general interest is by Dr. N. N. Sengupta on "Psychology, its Present Development and Outlook." The author reviews the chief trends of present-day psychological studies, relating them to their historical background, and outlines the more dominant schools of thought. He points out the enormous wealth of untouched material available in India, with its many races, religions, and cultures, enabling problems to be studied on a large scale, which in England are inevitably vitiated through insufficiency of data. He states that psychology in India is not so advanced as its importance demands, and gives as reasons its close dependence on philosophy, the tendency to be content with mystical explanations, the unnatural divorce between general and experimental work, and the vagueness as to its relation to physiology. It may be some consolation to the author to be assured that India is not the only country where such conditions prevail. The same difficulties appear in many English controversies. However, certain branches of psychology have emancipated themselves from the thraldom of preconceived notions and are making efforts to build securely on observation. India will doubtless not lag far behind. Dr. Sengupta makes a special plea for the co-ordination of many workers. If his schemes can be realised even in a small degree, India will have much to teach England, and we wish the new movement every success

WE much regret to announce the deaths of Dr. H. B. Guppy, F.R.S., distinguished for his work on plant dispersion and coral-reef formation in the Pacific, which occurred on April 23, at the age of seventy-one years; and of Mr. Stephen Paget, founder of the Research Defence Society and author of the biography of Sir Victor Horsley, on May 8, aged seventy years.

WE learn from *Science* that Dr. Edgar F. Smith, professor of chemistry at the University of Pennsylvania, has been awarded the second Priestley medal, bestowed every three years by the American Chemical Society upon a chemist for outstanding achievement in the science. The first Priestley medallist of chemistry was Ira Remsen, former president and professor of chemistry of the Johns Hopkins University.

MR. C. CUTHBERTSON, F.R.S., who is working at the Davy-Faraday Research Laboratory, 20 Albemarle Street, London, W.1, informs us that he requires 20 c.c. or more of krypton and xenon for research purposes. Inquiry at likely sources has been unsuccessful, and we understand that there is considerable difficulty in obtaining any of these gases in Great Britain. Mr. Cuthbertson would welcome information relating to available supplies.

THE Air Ministry announces that applications to enter machines for the Air Ministry Helicopter Competition, 1925–26, which closed last April, were received from thirty-four competitors, but only one competitor actually sent a machine to Farnborough, where the tests were to be carried out. This machine did not, however, carry out any of the tests, and none of the prizes offered has been won. It has been decided not to renew the competition.

THE following awards for the period 1923–25 have been made by the Royal Society of Edinburgh: Keith Prize to Prof. H. W. Turnbull, professor of mathematics in the University of St. Andrews, for his papers on hyper-algebra, invariant theory, and algebraic geometry, published in the *Proceedings of the Royal Society of Edinburgh*; Neill Prize to Prof. F. O. Bower, for his recent contributions to botanical knowledge, and in recognition of his published work extending over a period of forty-five years.

AT the end of the present session Prof. A. G. Perkin will retire from the chair of colour chemistry and dyeing in the University of Leeds, severing thereby a connexion with the University which has extended over thirty-four years. In view of Prof. Perkin's long period of service and the valuable work which he has done in building up a school of research into colour chemistry and the chemistry of natural colouring matters, work which is of great value to the textile and dye industries, a committee has been formed for the purpose of raising a fund which will enable the esteem in which Prof. Perkin is held to be signalised, either by the presentation to the University of his portrait, or in some other suitable manner. Subscriptions are invited for this purpose, and should be sent to Prof. A. F. Barker, The University, Leeds.

THE Royal Society will receive from Messrs. Brunner, Mond and Co., Ltd., a donation of 500*l.* in respect of the current year towards the cost of scientific papers on the physical side The Society will also receive a Publication Grant of 2500*l.* from H.M. Government during the current year. Both grants are available for helping the publications of other scientific societies as well as for assisting the separate publication of books, memoirs, etc., of a scientific nature. Applications for grants for the current year will be adjudged by the Council of the Royal Society at its meeting early in July, but should be received before the Council meeting of June 10. Applications from societies will be received by the secretaries of the Royal Society; those from individuals must be brought forward by members of Council.

The Rockefeller Medical Fellowships for the academic year 1926–1927 will shortly be awarded by the Medical Research Council, and applications should be lodged with the Council not later than June 10. These Fellowships are provided from a fund with which the Medical Research Council has been entrusted by the Rockefeller Foundation. Fellowships are awarded by the Council to graduates who have had some training in research work in the primary sciences of medicine or in clinical medicine or surgery and are likely to profit by a period of work at a university or other chosen centre in the United States before taking up positions for higher teaching or research in the British Isles. A Fellowship will have the value of not less than 350*l.* a year for a single Fellow, with extra allowance for a married Fellow; travelling expenses and allowances will be made in addition Full particulars and forms of application are obtainable from the Secretary, Medical Research Council, 15 York Buildings, Adelphi, London, W.C.2.

We much regret that in the paragraph in our issue of May 1, p. 630, referring to the bicentenary of the birth of Major-General William Roy, who initiated the primary triangulation of Great Britain, the name "Roy" was printed as "Ray."

The editors of "Organic Syntheses," an annual publication of satisfactory methods for the preparation of organic chemicals, now have at hand a large number of preparations in addition to those to be included in Volume 6, which is now in press, and in Volume 7, which will soon go to the printer Chemists interested in any of these preparations can procure copies from Prof. Frank C. Whitmore, Northwestern University, Evanston, Illinois.

Applications are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in geography in the University of Manchester—The Internal Registrar (June 21). A professor of anatomy at the Royal Veterinary College—The Secretary, Royal Veterinary College, Camden Town, N.W. (July 1). A radio engineer, a physicist or radio engineer, a radio engineer, and a radio experimentalist—The Secretary, Royal Engineer Board, 14 Grosvenor Gardens, S.W.1. A senior physics master at Oundle School—The Headmaster, The School, Oundle, Northants.

Our Astronomical Column.

Naked-eye Sunspot.—Two months have elapsed since the last appearance of a naked-eye spot, No. 5, reported in Nature for March 6. The present group of spots was seen as a naked-eye object for a few days only. It was of the typical 'stream' formation; that is, a well-defined regular spot followed at a distance of 8° or 10° of solar longitude by an irregular spot breaking up into a cluster. These two chief components are found to be almost invariably of opposite polarity. The longitude of this group is not far from that of the great northern spot of December and January, the position of which still remains marked by faculæ. Details of the new spot are as follows:

No.	Date on Disc.	Central Meridian Passage.	Latitude	Area.
6	May 8-20	May 13 7	20° S	1/1100

(Area expresses the proportion covered of the sun's hemisphere)

Nova in a Spiral Nebula.—A telegram from the I.A.U. Bureau, Copenhagen, announces the discovery of another faint nova in a spiral nebula, Messier 61, in the constellation Virgo. The position for 1926·0 is R.A. $12^h\ 18\ 3^m$, N. Decl. 4° 54′. The magnitude is given as 13. The discovery was made at the Königstuhl Observatory, Heidelberg, by Prof. M. Wolf and Herr Reinmuth, evidently by photography. The spiral character of this nebula was detected at Parsonstown by the late Earl of Rosse.

The nova is distant 70″ from the nucleus, in position angle 351°.

It is important to follow these distant novæ for as long a time as possible, in order to compare their light-curves with those of galactic novæ. It will be remembered that Dr. Hubble was able to trace the light-curves of the faint Cepheids in M31 and M33 down to magnitude 19 or 20.

The Sun's Velocity derived from Faint Stars.—*Lick Observatory Bulletin* No 374 describes a research by P. van de Kamp on the solar velocity derived from the radial velocities of stars of average magnitude 9·2. The research was intended to test Seares's result that the sun's velocity is greater with respect to faint stars than to bright ones, amounting to 25 km./sec. for tenth-magnitude stars. The spectra were photographed with a one-prism spectrograph mounted on the 36-inch refractor The scale is small, and the individual results rather untrustworthy, but the errors should nearly go out in the mean. The list comprised 105 stars, equally divided between the apex and antapex regions. Their spectral type is as follows (from Henry Draper Catalogue): A and F 45 stars, G 32 stars, K 28 stars.

The resulting value of the sun's velocity is 18 km./sec., the values from the different spectral types being accordant. This value is slightly smaller than the usually accepted value, derived from brighter stars, and thus fails to support Seares's hypothesis. Some other approximate methods of obtaining the velocity with respect to faint stars are discussed, and found to indicate still lower velocities than the present research. The absolute magnitudes of the K stars were estimated as lying between −1·6 and +3·1, so that none of them are faint dwarfs. The assumed position of the solar apex was R.A 270°, Decl. +30°.

Research Items.

THE HUMAN FACTOR IN ACCIDENTS.—The importance to industry of a study of accidents, major and minor, cannot be exaggerated, but when definite causative relations are sought the difficulties and complexities seem to render scientific treatment almost impossible. The immediate relation is between machinery and an accident, and quite rightly have efforts been made to diminish the risk due to machinery. More detailed study reveals, however, a number of determinants which point to less obvious factors. Report No. 34 of the Industrial Fatigue Research Board (H.M.S.O., price 5*s.*) is a contribution by Miss Newbold to the study of the human factor in the causation of accidents. It is a statistical analysis of minor accidents reported from many firms and covering a considerable period of time. It is found (1) that in nearly all the groups the average number of accidents is much influenced by a comparatively small number of workers, and that the distributions among the workers are far from chance; (2) that there are many indications that some part is due to personal tendency; (3) that the people who have the most accidents are, on the whole, those who pay most visits to the ambulance room for minor sicknesses The study is very important not only for what it brings forward in the way of positive evidence, but as an example of scientific method applied to a very difficult problem where vague speculation and prejudice frequently masquerade as fact. The writer suggests that further detailed investigation should be undertaken along the lines of individual study and experimental psychology.

MAN IN THE GLACIAL PERIOD IN GREAT BRITAIN.—In *Man* for April, Mr. J. Reid Moir discusses the inferences to be drawn from the discovery of a palæolithic implement on the foreshore at Eccles-on-Sea, Norfolk, by Mr. W. W. R. Spelman. The implement is an oval core-implement, unpatinated and unrolled. Its form and flaking assign it to the class of specimens concerning which, in the present state of our knowledge, it can only be stated that they belong either to Late Chelles or Early Acheulean. The unabraded condition of the implement suggests that it must have been uncovered just prior to discovery from a bed underlying the beach, as the sandy beach and low cliff reveal no humanly flaked flints. Such a bed must have been the stratum designated as 'First Till' In all probability the First Till represents one of the deposits laid down during the second Glacial Period of East Anglia, and was separated from the Upper Chalky Boulder Clay (of the third Glacial Period of East Anglia) by the inter-glacial phase represented at Hoxne, Foxhall Road, Ipswich, and elsewhere. As St. Acheul implements occur in this phase, it becomes of importance to ascertain whether the present implement is of Chellean or Acheulean date. The main fact, however, is that a definite flint implement of Lower Palæolithic Age has been found under conditions making it probable that the specimen was derived from a glacial boulder clay and thus affords additional evidence of the existence of man in England during the glacial period

RESEARCH IN THE FAYUM—In *Ancient Egypt* for March, extracts are given from correspondence from Miss Gertrude Caton-Thompson, and Miss Elinor W. Gardiner, who are working in the Fayum on behalf of the British School of Archæology in Egypt with the view of linking the archæology to the close of geological changes. Writing from Dimeh, a little south of the lake, Miss Caton-Thompson says that it is plain that there was more than one simple rise and fall of the lake in Pleistocene times. A shore line 189-190 feet above the present lake (46 ft. over sea) yields much evidence of the prehistoric people. On a slope down to the Birket Qarun, flint was obtained at 176 feet on a ridge on which it was unlikely to have been washed (*i.e.* 32 feet over sea, submerged since 9000 B.C.). Pigmies with pigmy cores came down to 138 feet (6 feet below sea, submerged since 17,000 B.C.). Investigations at Kom have settled the question of the contemporaneity of the polished flints, the pottery, and the bone arrows, but only one culture is represented Miss Gardiner writes that the most important fact in the geology of the area is that the Fayum people were living on an old lake surface and not tertiary rock as supposed. There is distinct evidence of two lakes. The older dried up and the deposits denuded very considerably before the waters of the second lake gained access to the Fayum. A section in a wady shows gravels full of flints, mostly wind worn, at 185 feet above lake level, probably belonging to the older lake beds. The surface of the gravel is 185 feet above lake level (submerged since 8000 B.C.). A considerable number of Fayum implements were found upon it. (The statements in brackets are from explanatory notes by the editor of *Ancient Egypt.*)

A DIET CHART.—We have received a copy of the "Grassendale" Diet Chart prepared by S. G. Willimott and Frank Wokes, Grassendale, Liverpool (price 6*d.*), which appears to have been designed for the benefit of the general practitioner of medicine who wishes to place his patient on a known diet before sending samples of blood, urine, etc., to a biochemical laboratory for chemical examination. At the same time, it should be of use to all who wish to treat their patients by means of strict dieting. The information given on the chart is comprehensive: for a large variety of natural, and a few patent, foods the following data are set forth in a series of columns; the percentage composition (carbohydrate, protein, and fat), the energy value, the digestibility coefficient of the carbohydrate present, and the most important of the inorganic elements contained in the food, and whether it leads to the formation of acid or base in the body, its relative power in this respect being indicated by a numerical figure. At the same time, the relative content of the material in the three vitamins, A, B, and C, and the presence of purines, are also indicated Blank columns are given for entering the amounts of each food eaten in the twenty-four hours and for the results of the calculations of the quantities of protein, fat, or carbohydrate assimilated. Explanatory notes of the chart are given on the back: those on vitamins might perhaps have been a little clearer; dry seeds contain vitamin B, but on germination it is vitamin C which appears in large quantities. The information given in the chart should be of use in dieting cases of diabetes mellitus, gout, and nephritis, being available in a compact and handy form; whilst sent to the laboratory with the specimen it will enable a more correct interpretation to be placed on the results of the chemical examination

THE SWIM BLADDER OF SOME INDIAN FISHES.—In his thesis recently presented to the Faculty of Sciences in Paris, D R. Bhattacharya has given an account of the structure and relations of the swim bladder of Indian fishes belonging to the families Sciænidæ and Ophiocephalidæ In the former the swim bladder is oval and extends the whole length of the abdomen. Issuing from it is a complex system of branches passing to the head and to the tail—those in the head region have an arborescent form, and some of them enter into relation with the auditory capsule, being separated from the perilymph only by thin fibrous tissue. Some of the blind branches also penetrate the operculum and the pectoral fin and their ends come to lie just under the skin. In *Sciænoides pama*, two lateral lobes arise from the swim bladder and extend between the peritoneal epithelium and the body-wall and form a complete sac around the body cavity. A dorsal sac is formed in a similar manner and completely envelops the swim bladder dorsally. The two sacs meet laterally, and thus in a dissection one comes upon this large sac enveloping the swim bladder. In the Ophiocephalidæ the swim bladder is an elongate sac extending from the anterior part of the abdomen to the tail, and does not give off diverticula. Details are given of the glands of the swim bladder in each family.

Effect of Light on the Movement of Earthworms.—E. Nomura has made (*Science Reports Tohoku Imp. Univ.*, Japan, fourth series, vol. 1, pp. 293-409, 1926) careful investigations on the effect of light on the movement of *Allolobophora fœtida* to test the differential effect of light on fresh and on fatigued worms, to ascertain the average limit of the free or random movements, the influence of light—horizontal, and from above, and in flashes—on worms with the cerebral ganglia removed and on worms in the course of regeneration. His general conclusions may be summarised as follows: The orientation of the worm is determined by the antagonistic functioning of the cerebral ganglia and of the ventral nerve cord. The brain causes negative orientation and forward crawling, while the nerve cord causes positive orientation and crawling either backwards or forwards. By the predominant influence of the brain the longer exposure to light of stronger intensity causes the stronger negative phototaxis. With light of a given intensity the strongest negative phototaxis is produced when the light rays fall at an angle of about 25° to the horizontal. The most anterior part of the ventral nerve cord causes the strongest positive orientation, the more posterior parts cause a progressively less pronounced reaction—that is, the worms exhibit axial gradient in these reactions.

Some non-Marine Mollusca of the Western Hemisphere.—A fifth part of Dr. H. A. Pilsbry's notes and descriptions of South American land and fresh-water molluscs, that were begun in 1924, has appeared detailing various new species, including one of that remarkable land snail Megaspira (*Proc. Acad. Nat. Sci. Philad.* 77). The same author on later pages in the same publication, deals with other new non-marine mollusca. The most remarkable of these is a very small Physa from Zion Canyon, Utah. No snail can be found in the swift-running stream at the bottom of the canyon, but where the water trickles out of the rock joints of the almost vertical walls of the canyon, the wet rock faces become coated with green algæ, and it is on these isolated patches of algæ the little *Physa zionis* lives. This account is followed by descriptions of new non-marine shells from Querétaro, Mexico.

Modifications in the Calyx of Primula.—Since recording in Nature of April 10, p. 518, the occurrence in phyllody of the calyx *Primula vulgaris* (Huds.), Mr. F. R. Browning writes that he has seen hybrids of *P. vulgaris* with *P. veris*, sometimes termed *P. variabilis*, Goup., showing a completely petaloid calyx. The three flowers examined were 'pin-eyed,' two of them having five petals and five petaloid sepals, which alternate with them normally. The third flower has six petals and five petaloid sepals; the sixth is diminutive though decidedly petaloid. It also differs from the others in that it has not the well-marked ridge at the midrib, which characterises the other sepals. The size attained by this unusual calyx is in all cases the same as that attained by its enclosed corolla.

Domesticated Plants in Spanish America.—An interesting field of research is opened up in a paper on the plant content of adobe bricks by George W. Hendry and Margaret P. Kelly which has been published by the California Historical Society. Missionaries and travellers who visited California in the Spanish period are known to have introduced a number of cultivated plants into the country, but precise information, especially as to varieties, is lacking. An examination of bricks from a number of buildings, ranging in date from 1771 to 1845, although representing a small sample only, has furnished a considerable amount of exact information on the point. The adobe bricks were made of a variety of soils, ranging from sandy loam to heavy loam, some natural, others the result of artificial mixing, and contained organic matter chopped into two-inch lengths, usually wheat or barley straw, but also weeds and grasses of various kinds. Of the twenty-two weeds, eleven are introduced European species. Six varieties of wheat were identified. This establishes a new date for the introduction of Big Club wheat (*T. Compactum Humboldti*) not previously known as a mission crop. One wheat, California Club wheat (*T. Compactum Crinaceum*), is not grown in California to-day, but disappeared prior to the Mexican period (1822–45), and another, a beardless wheat (*T. Vulgare Albidum*), is unknown. Propo wheat (*T. Vulgare Graecum*), supposed to have been introduced from a Chilean strain about 1875, was also found, and may have persisted from the original Spanish stock. Only one variety of barley (*H. Vulgare Pallidum typica*) was found. One wild oat kernel is of doubtful authenticity. Of two cultivated oats, *Avena sativa*, which belongs to a group not adapted to central California, may represent an unsuccessful experiment.

Chromosomes of Roses.—In a reprint from his *Experiments in Genetics*, Dr. C. C. Hurst discusses the origin of species in Rosa. Starting with a hypothetical decaploid rose (which would have ten times seven chromosomes), he supposes that the various septets of chromosomes became differentiated under subpolar conditions, so that each set was pre-adapted to a different climate. This all happened within a single (hypothetical) decaploid species of rose. The hexaploid, pentaploid and diploid existing species were afterwards formed by the throwing off of different septets of chromosomes successively until the present diploid species were arrived at, each adapted to different conditions. This highly hypothetical speculation is contrary to all that is known concerning polyploidy in other plants. It also implies a sort of evolution *in vacuo* of the chromatin, which is contrary to every experimental evolutionary view of the relation between the organism and its environment. The evidence from other plant genera is that polyploid species are derived from diploid ancestors, and not the reverse.

Mean Sea-level in the Oceans.—The relation between wind or current and mean sea-level in the Indian and Atlantic Oceans and adjacent seas is discussed by P. H. Gallé in a short paper in the Proceedings of the Koninklijke Akademie van Wetenschappen te Amsterdam, vol. 27, No. 10. Mr. Gallé concludes that the range in mean sea-level is mainly due to fluctuations of wind and current, either near at hand or far distant. He believes that while the north-east trades and the equatorial current are causes of fluctuations in mean sea-level on the European coast, the main cause must be looked for in fluctuations of the north Atlantic high- and low- pressure systems. The correlation factor between monthly departures of the velocity of the current and strength of the wind and departures from mean sea-level is given as varying between 0·829 and 0·957. The time relation between changes of velocity in the equatorial current and mean sea-level on Atlantic coasts varies from one month in the Azores to three months in the English Channel and four months on the north coast of Norway.

Atlantic Doldrums.—The Meteorological Office, Air Ministry, in "Geophysical Memoirs," No. 28 (London: H.M. Stationery Office, 1926. Price 1*s.* 6*d.* net), has issued a discussion of "The Doldrums of the Atlantic" by Mr. C. S. Durst. The author rightly gives considerable credit to Captain Toynbee, the first Marine Superintendent of the Meteorological Office, for his study of this district and the publication of the observations for the Nine Ten-Degree Squares comprising the area of the Atlantic Doldrums. A previous discussion was undertaken of Square 3. The copious letterpress accompanying these charts by Captain Toynbee is full of valuable information, especially on the direction of upper clouds with the different surface winds. The author notes that the minimum of pressure in the Doldrum belt follows the position of greatest humidity rather than the position of maximum temperature, and he is of opinion that over the ocean it would seem that convection must be started dynamically rather than thermally. If obtainable, synchronous weather charts over the Doldrum area would add much to our present knowledge of this interesting region.

The Colour of Red Formations.—In the *Journal of Geology*, No. 2, 1926, a valuable discussion of the origin of the colour of red beds is presented by G. E. Dorsey. It is shown that the non-red rocks often contain more iron and even more ferric oxide than do the red beds. The red colour is due not merely to oxidation—which is widespread—but to dehydration. Favourable conditions for the production of the red hydroxide, turgite, and the red oxide, hæmatite, are found in warm moist climates, and not, as has previously been asserted, in deserts or semi-arid regions. Ferric hydrate turns red spontaneously by dehydration, even under water, if given time enough. In the tropical belts heat favours dehydration, and the heavy cover of vegetation keeps the soil from being rapidly removed, so that time is available for the reaction to proceed. Most sediments are carried to the seas and there, exposed to the reducing action of the decay of marine organisms, they lose any red colour they originally possessed. But red detritus is able to retain its colour if it comes to rest upon the continents where no widespread reduction is in progress. Thus for the most part the red formations of the geological column represent continental deposits; though it is recognised that occasional wedges may be found in marine series, like that now forming off the mouth of the Amazon, where fresh water and red detritus are sufficiently abundant to force the true marine conditions farther off-shore.

Investigations on the Earth's Crust.—The *Year Book*, No. 24, for 1925 of the Carnegie Institution of Washington includes, *inter alia*, reports on the work of (i.) the Geophysical Laboratory directed by Arthur L. Day, (ii.) the Advisory Committee on Seismology, and (iii.) of certain physicists associated with the Institution. The latter include S. J. Barnett, formerly attached to the Department of Terrestrial Magnetism, who is continuing his valuable researches on rotation by magnetisation, and vice versa, at the California Institute of Technology, Pasadena. Much of the work done under R. A. Millikan in the Norman Bridge Laboratory at Pasadena is also subsidised by the Institution. In the Geophysical Laboratory at Washington a large part of the work has consisted of experiments involving very high pressures; the attainment of a pressure of 15,000 atmospheres (225,000 lb. per sq. in.) on a small sample of material has now become "a matter of simple routine"; this corresponds to the pressure at a depth of 30 miles below the surface of the earth. Still higher pressures are readily obtained, but beyond the limit stated the work is liable to be interrupted by expensive and annoying explosions. The compressibilities of the more important rocks and minerals have been investigated under these high pressures: the results are of special interest in determining the speed of earthquake waves through the earth. Less directly, the work bears on the temperature within the earth, and has led to an estimate of 850° C. at 30 miles depth, and 1700° at 100 miles, values which are much lower than has generally been supposed. Laboratory studies and 'field' observations (at Vesuvius and elsewhere) on volcanic problems have also been considerably advanced. The Committee on Seismology plans to establish a central seismological laboratory at Pasadena, and has completed the development of new instrumental installations for the accurate measurement of the horizontal and vertical components of local as distinct from widespread earth movements (such as ordinary seismographs record). It is hoped to furnish a considerable number of seismological stations with such installations. In co-operation with the Coast and Geodetic Survey, triangulations are in progress for the determination of relative surface displacements in a large region around California. The measurements already made indicate that the stations on the west side of the fault between Monterey and the Santa Barbara Channel have all been moving northward, the maximum movement recorded, whatever its source, being about 24 feet, at a station situated a few miles west of the city of Santa Barbara.

A Microluminometer Light Source.—At the meeting of the Physical Society on May 14, Dr. Fournier d'Albe demonstrated an apparatus for producing very minute measurable fluxes of light and illumination. The original source of light was a small glow lamp of ⅛ c.p. candle power, which illuminated a ground-glass disc with an aperture of ¼ in. This disc acted as a secondary source of $\frac{1}{16}$ c.p. in the direction of propagation. A number of lengths of tubing, 2 in. long, were telescoped together, each length ending in a $\frac{1}{16}$ in. diaphragm covered with ground glass. The amount of light emerging from each successive diaphragm was $\frac{1}{250}$th part of the light emerging from its predecessor. The candle power thus obtained was $1·6 \times 10^{-4}$ c.p. at the first stop, $6·4 \times 10^{-7}$ c.p. at the second stop, $25·6 \times 10^{-10}$ c.p. at the third stop, and 10^{-11} at the fourth stop. The light emerging from the fourth stop is quite invisible, even after prolonged accommodation, and represents, indeed, a star of about the seventh magnitude. The microluminometer source is intended for a comparison of the efficiencies of photoelectric cells and selenium respectively in detecting faint light. It is claimed that the faintest source is measurable within 2 per cent.

The Indian Science Congress at Bombay.

UNDER the presidency of Mr. A. Howard, Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to States in Central India, the thirteenth annual meeting of the Indian Science Congress was held at Bombay on January 4-9. In addition to sectional meetings, joint discussions were held on recent scientific work directed to the improvement of cotton-growing (Sections of Agriculture, Mathematics and Physics, Zoology and Botany) and on the structure of the atom and quantum theory (Sections of Mathematics and Physics and Chemistry). Public lectures on droughts and famines, by Dr. H. H. Mann, on life at higher altitudes in Western Tibet, by Prof. Shiv Ram Kashyap, and on modern applications of X-rays, by Prof. H. Parameshwaran, were arranged, as well as visits to places of scientific interest in the neighbourhood of Bombay.

Brief accounts indicating the activities of some of the sections of the Congress are printed below.

In his presidential address, Mr. A. Howard, after dwelling on the predominance in modern scientific agriculture of the biological sciences, went on to stress the diversity of the sciences with which modern research in agriculture is concerned. The study of the growth of the economic plant, according to Mr. Howard, opens up the great problem of the agriculture of the near future, and that is the *intensive* cultivation of improved varieties; it is not sufficient to breed new varieties: the methods by which maximum production can be obtained must be studied. From his general argument, Mr. Howard developed the thesis that the need of the future is team work. The real subjects of research in agriculture have far outgrown the old tradition inspired by the work of Liebig: the attack through a single science is no longer possible. It is rightly pointed out, however, that successful team work presupposes the presence of a competent leader and, it may be added, a spirit of subordination to which men with the real pioneering aptitudes do not readily submit.

An unusual and suggestive feature of Mr. Howard's address was the special reference to the connexion between canal irrigation and public health. He thinks that no satisfactory explanation has yet been given of the correlation between canal irrigation and the prevalence of malaria. He pointed out that the connexion cannot be wholly due to the formation by canals of breeding grounds for mosquitoes, and suggested that a contributory cause may be nutritional—the deficiency in the food crops grown with canal water of essential mineral and other ingredients. He urged the need for immediate investigation and deplored the cessation, for financial reasons, of the work of McCarrison (*Jour. Roy. Soc. of Arts*, 83, 1925, p 152) in this direction. This investigator showed that certain nutritional diseases were prevalent in Madras as the result of differences in the manurial treatment of the millet crop.

In relation to the diseases of plants, also, Mr Howard broke fresh ground with a suggestion that cultural conditions rather than specific infection play the most important part in the causation of outbreaks. In some of his work at Quetta in connexion with fruit growing, he was able to show that attacks of aphis could be induced experimentally by altering the time of irrigation. He found, again, that Eincorn (*Tr. monococcum*), which is generally believed to be immune to *Puccinia graminis*, becomes highly susceptible when grown in the hot climate of Pusa in Bengal Mr. Howard's reputation in applied botany is so well established that his views, particularly on possible administrative developments, merit serious consideration.

The programme of the Section of Anthropology indicates an active and serious interest in the varied problems of Indian ethnology and culture. If, however, those who took part in the proceedings had flung their nets wide, it is to be regretted that the burden of ethnological investigation still appears to rest on the shoulders of a few, and that the number of individual workers taking part was small. Further, while religious and sociological investigations were well represented, the study of material culture received little attention.

Among so many communications presenting features of interest it may appear invidious to select any for mention; but attention may be directed to Mr. L. A. Cammiade's account of the Kurnool bone caves in relation to the problem of prehistoric man in India, Sarat Chandra Roy's description of the Asurs, a tribe of iron-smelters of Ranchi; Sarat Chandra Mitra's record of two recent cases of exorcism, one from Southern Bengal, for driving out the spirit of disease sent by Kali, a second from eastern Bengal, where treatment of a person possessed of a ghost by repeated immersion in water resulted fatally. The same author recorded two cases of propitiation by self-mutilation: a man cut off the tip of his tongue as an offering to Tapeswari at Cawnpur, while another individual in Kathiawara cut off his own head as an offering to Siva. An interesting rite to prevent hydrophobia, also recorded by Sarat Chandra Mitra, involves the turning by incantations, but otherwise unaided, of a saucer on which the patient stands. D. N. Majumdar presented further communications dealing with the customs of the Hos of Kolhan in continuation of those already published in several Indian periodicals.

In the Section of Zoology, under the presidency of Prof. H. R. Mehra of Benares, twenty-nine of the thirty-one papers presented are by Indian workers. They afford evidence of considerable scientific activity in the observation more especially of protozoa, parasitic worms, and Arthropoda.

Under the presidency of the Rev. W. E. Blatter, no less than 52 papers were communicated to the Section of Botany. These range over a wide field, many of them recording results of very general interest The president is himself responsible for several ecological papers, mainly on the Indus delta; C. McCann also presented several papers on the grasses of the Bombay presidency; whilst several Indian workers supplied records of studies of special vegetation formations. The life-history of various Indian plants also received attention; a number of interesting communications in plant physiology are reported, and papers on parasitic fungi, on marine and fresh-water algæ, on cytology, teratology, heterophylly, and other biological features of interest in Indian plants, are included In fact, the proceedings of the section suggest that the prosecution of research upon the interesting vegetation of India is actively pursued, and that Indian investigators are themselves taking a prominent share in the work.

The proceedings of the Section of Geology were noteworthy for the many papers devoted to Burma and its problems. A. S. Subbaiyer dealt with the production and reserves of petroleum and its stratigraphical distribution He concludes that there may still be vast unexplored resources in the little-known Eocene oil-fields. In a third paper he discussed the genetic relationship between coal and oil, and suggests mapping the fixed carbon ratios in conjunction with structures as likely to lead to successful results, particularly along the Pakokku foot-hills. H. L. Chhibber contributed a valuable account of the extinct volcano Mt. Popa, one of the most conspicuous landmarks of Upper Burma. He also described the ferruginous concretions of the Irrawaddian Series, and the ancient slag-heaps and deserted furnaces found in the neighbourhood of Mt. Popa. Another paper by the same author described ferruginous bands of a rhythmic character occurring in the silicified tuffs of Kyankpadaung. H. L. Chhibber and L. D. Stamp collaborated in a paper dealing with the origin and constitution of the fossil wood which is such a conspicuous feature of the late Tertiary beds of Burma. The petrography of Green Island, near the mouth of the Salween, is described by L. D. Stamp, who directs attention to the extensive assimilation, lit-par-lit injection, and development of banded gneisses that have taken place. K. K. Mathur *et aliter* discussed the mechanism of intrusion and the differentiation of the laccolith of Mt. Girner, the rocks of which were described many years ago by Dr. J. W. Evans. The Ranikot beds at Thal were shown by L. M. Davies to present a more complete series of the earliest Eocene horizons than has been discovered elsewhere. B. Sahni is engaged on a revision of the fossil plants in the collection of the Geological Survey, and presented a summary of his work on the conifers, ranging from the Lower Gondwana to the Cretaceous. Other papers dealt with cordierite, staurolite and mica, and various local faunas and strata; and J. Ribeiro describes the natural caves recently discovered in Bombay. The large number of contributors and the wide variety of subjects discussed testify to the healthy activity of geological research in India and Burma.

Nearly a hundred papers were presented to the Section of Mathematics and Physics. Seven of these deal with pure mathematics, five with hydrodynamical problems, and two with relativity and non-Euclidean space. The physical papers cover a wide range. Surface tension, efflux of gases, motion of projectiles, vibrating strings, flame temperatures, entropy, radiation, scattering of light, spectra, X-ray investigation of crystals, magnetism, electrolysis, photo-electricity and wireless signalling, were all discussed, while the weather, rainfall and floods of Bengal were not forgotten. Prof. M. N. Saha, as president of the section, read a valuable paper on the application of subatomic thermodynamics to astro-physics, portions of which were printed in NATURE of May 8. The programme showed that India is keeping well abreast of recent developments in the mathematical and physical sciences.

Co-operation in Oceanography.

UNDER the title "L'Oceanographie dans la Vie International," Prof, Odon de Buen writes an interesting account of the various organisations which are materially assisting the co-operation of adjacent countries in oceanographical investigations (*Scientia*, February 1, 1926). The international movement is particularly active both in physical and biological oceanography, where the problems encountered by each country extend far beyond its own coasts, and the natural difficulties and expense of collecting data at frequent intervals over a wide area of the ocean necessitate such collaboration.

This necessity is increasing. Our present knowledge of the average conditions of the seas is built up from numerous painstaking observations made by a limited number of expeditions carried out from time to time. The fluctuations in the fisheries, of national importance to the countries concerned, centre interest more and more upon the fluctuations rather than upon the average condition in the physical and chemical conditions of the seas.

The Conseil Permanent International pour l'Exploration de la Mer now includes those countries bordering on the continental shelf from Norway to Portugal and Spain. Its influence in furthering our knowledge of the oceans in general has been potent since its foundation in 1899. Similar organisations deal with the publication of data and the co-ordination of investigations, both in the Mediterranean and also in the fertile area famed for its cod fishery north-east of North America.

These three co-ordinating organisations are represented in the Oceanographical Section of the Union International Geodesique et Geophysique by their respective presidents It is of interest to hear that this section has commenced the difficult enterprise of publishing an annual *Bibliographical Bulletin*.

As any feral industry grows, whether it be hunting animals or fish, an accurate knowledge of the factors which control fluctuations in the population of the hunted animal becomes increasingly useful to the hunting nations. It is to gather this knowledge that the network of organisations has sprung up, fathered originally by the Scandinavian countries, to whom their fishing industry is an asset of relatively great importance. An interest in the sea is inherent in all seafaring nations, and concerted action has already been of great help to the progress of scientific oceanography.

The Swiss National Park.

PROF. CARL SCHROETER of Zürich delivered the fourth Hooker lecture at the Linnean Society on April 15 on the Swiss National Park. The movement for Nature protection is very strong in Switzerland, and civil law permits even expropriation in the interest of natural and historical monuments. The formation of the League for the Protection of Nature (Naturschutzbund) has made the matter a national one; it has about 30,000 members, who pay an annual subscription of 2 francs, or 50 francs for life membership. The League has been instrumental in many ways, but the most effective measure is the creation of the Swiss National Park, which occupies about 54 square miles in the Lower Engadine. Here shooting, fishing, manuring, grazing, mowing and wood-cutting are entirely prohibited. No flower or twig may be gathered, no animal killed, no stone removed, and even fallen trees must remain undisturbed. There are no hotels, only simple Alpine shelter huts, and camping and the lighting of fires is not allowed. The aim is to exclude the effect of human interference so far as possible: scenery, plants and animals are absolutely protected.

The Park is controlled by five trustees nominated by the Government, which pays the rent (up to 30,000 francs per annum). The League pays the incidental expenses (*e.g.* there are four resident keepers) and for scientific research which is organised by the Swiss Society for the Advancement of Science.

The size of the Park and its physiography allow of Nature equilibrium. The mean elevation is high; the snow-line consequently reaches so much as 3000 metres; the tree-limit 2300 metres. It is well wooded with extensive forests of the erect mountain pine (*Pinus* *montana* var. *arborea*) and *Pinus Cembra*, mixed woods of spruce and larch, an endemic variety of Scotch pine (*Pinus sylvestris* var. *engadinensis*), and extensive areas of creeping mountain pine (*P. montana* var. *prostrata*). The herbaceous flora is rich and varied, the different geological strata allowing of both calcicole and calcifuge plants; the division between the floras of the western and the eastern Alps passes through the Park, many of the Swiss eastern species occurring only here. Animal life is abundant—chamois, marmots, deer, roes, foxes, mountain- and heath-cocks, golden eagle, etc.

After ten years of reservation the favourable effect is clearly visible: the flora of the now abandoned pastures has developed abundantly. The number of animals has much increased. From 1918 to 1925 deer had increased from 12 to 90; roe from 60 to 190; chamois from 1000 to 1250; mountain cock from 10 to 60, heath-cock from 40 to 190; ptarmigan from 120 to 310, and golden eagle from 15 to 40. The preservation of certain beasts of prey is requisite as a hygienic measure, as they kill sick animals first.

The last bear was killed in the Park in 1904. The ibex disappeared from Switzerland in 1809, but an effort is being made to reintroduce it from colonies at St. Gallen and Interlaken, which have arisen from young animals smuggled from the valley of Aosta.

All the influences of man due to shooting, fishing, wood-cutting, haymaking and so on will take time to efface, and the successional changes are being studied by a special commission of fourteen members elected in 1915 and divided into four sections, geologico-geographical, climatological, botanical, and zoological. So far forty investigators have worked in the Park. Several monographic studies have been published, and an attempt is being made to get a "complete notion of the inorganic and organic nature of our National Park."

The lecture was illustrated by a magnificent series of coloured lantern slides.

University and Educational Intelligence.

BRISTOL.—The Society of Merchant Venturers offers for competition fifteen scholarships tenable in the Faculty of Engineering of the University of Bristol, provided and maintained in the Merchant Venturers' Technical College. Candidates must be not less than 17 years of age and must have matriculated. The scholarships provide free tuition: one of the scholarships is open to pupils in any secondary school receiving grants from the Board of Education; three are restricted to pupils of secondary schools in the counties of Gloucestershire, Somerset, and Wiltshire (one to each county); ten are restricted to the sons of officers in His Majesty's Service who were killed in the War, and whose mothers or guardians are in needy circumstances; one is restricted to a son of a citizen of Bethune who has passed either the B. ès L. or the B. ès Sc. examination. A War Memorial scholarship is also offered, with a preference to a candidate who needs pecuniary help, who is the son of a former student who lost his life while serving with H.M. Forces during the War.

CAMBRIDGE.—The late Sir John B. Harrison bequeathed to the Sedgwick Museum his collection of more than 2000 rock slices; these were made from the rocks of British Guiana and the West Indies.

Dr. F. J. Gaskell, of Gonville and Caius College, has been appointed demonstrator in medicine, and Mr. E. G. Holmes, of Christ's College, has been appointed as assistant to the Downing professor of medicine.

A lectureship in advanced and economic entomology has been advertised as vacant; the stipend will be 350*l.* with a "fellowship allowance" of 150*l.* if the holder is not a fellow of a college. From this it would seem that the principle of granting an extra emolument to persons on the staff of the University who are not fellows of colleges has been conceded. Similar provisions are made in the conditions of appointment to lectureships in moral science and Persian which are also announced.

The General Board of Studies has presented a report on the readership in ethnology. The present office was created for the duration of Dr. Haddon's tenure, and he has announced his intention of retiring at the end of the present academic year. The Board considers that the subject is now well established in Cambridge and its educational importance generally admitted; it is therefore suggested that the readership should become a permanent university post.

OXFORD.—On May 12, Mr. G. R. de Beer, fellow of Merton College, the lately appointed John Wilfred Jenkinson lecturer in embryology, delivered an inaugural lecture on the organisation of the embryo. He made special mention of the embryological work of the late J. W. Jenkinson, in whose memory the lectureship has been founded; and directed particular attention to the orientation of the embryo, as manifested in the results of transplantation and in the phenomena of the 'grey crescent.'

DR. I. J. KLIGLER, formerly of the Rockefeller Institute and for the past three years Director of the Malaria Research Unit attached to the Department of Health of the Government of Palestine, has been appointed head of the new Department of Hygiene established at the Hebrew University of Jerusalem.

THE University Grants Committee's Returns for 1924–25 give 41,794 as the total number of full-time students of both sexes in the universities and university colleges of Great Britain in receipt of Treasury Grants. This is less by 1098 than in the preceding year, but the decrease is more than accounted for by the decrease (1458) in the number of students assisted under the Government scheme for the higher education of ex-service men. The tables in which the full-time students are classified according to faculties show decreases under medicine (970 men and 367 women) and technology (496 men) and increases under arts, including theology, fine arts, law, music, commerce, economics, and education (557 men and 353 women). A large proportion of the decrease in the medical group is accounted for by the dental students. In the Scottish Medical Schools there were 537 fewer men and 178 fewer women last year than in the year before. Under engineering, metallurgy, and applied chemistry there were decreases: from 3413 to 3036, from 187 to 140 and from 338 to 280 respectively, whilst the number of mining students increased from 263 to 275. The table exhibiting the home and university residence of full-time students shows that 49 per cent. came from homes within a 30-miles radius, 42 per cent. from other parts of the British Isles, 6 per cent. from other parts of the British Empire, and 3 per cent. from foreign countries. Of the men, 19 per cent., and of the women, 33 per cent. were accommodated in colleges or hostels. Next to Oxford and Cambridge and the Durham Colleges, University College (now the University of) Reading ranks highest in regard to the number of full-time students thus accommodated. The number of students in lodgings was 14,070, or 34 per cent. of the total number.

Contemporary Birthdays.

May 15, 1847. Sir E. Ray Lankester, K.C.B., F.R.S.

May 18, 1867. Prof. Edward Fawcett, F.R.S.

May 19, 1876. Prof. William King Gregory, Corr. Mem. Zool. Soc. Lond.

May 22, 1860. Major B. F. S. Baden-Powell, F.R.A.S.

May 23, 1864. Sir Arthur Smith Woodward, F.R.S.

Sir E. RAY LANKESTER, emeritus professor of zoology in University College, London, and a foreign member of the Paris Academy of Sciences, is a Londoner. He was educated at St. Paul's School, Downing College, Cambridge, and Christ Church, Oxford. From 1891 until 1898 Lankester was professor of comparative anatomy in the University of Oxford; afterwards he was for some years Fullerian professor of physiology in the Royal Institution. In 1898 he was appointed director of the Natural History Departments of the British Museum, retaining office until 1906. Just over forty years ago he received one of the Royal medals of the Royal Society, at the hands of Prof. Huxley, its president, for labours even then extending over two decades, in the field of animal morphology and palæontology. We believe that no other man of science lives to-day who can lay claim to any kindred personal act on Huxley's part. "Prof. Lankester," said the president, "has been active in many directions, and has everywhere left his mark, not only as an energetic teacher and accurate worker and a philosophical thinker; but as one who, in times when the example is more than ever valuable, has always been careful to remember that speculation should be the servant and not the master of the biologist."

Prof. FAWCETT, who holds the chair of anatomy and is Dean of the Faculty of Medicine in the University of Bristol, was educated at Blencow Grammar School and the University of Edinburgh.

Prof. WILLIAM K. GREGORY, palæontologist and morphologist, was born at New York City, and educated at Columbia University. Research assistant to Prof. H. F. Osborn (the newly-elected foreign member of the Royal Society) from 1879 until 1913, he afterwards became assistant curator of the Department of Vertebrate Palæontology in the American Museum of Natural History, where he is now curator of the Department of Comparative Anatomy. On his special subjects Prof. Gregory has long been an illuminating lecturer in Columbia University. He is the author of "The Orders of Mammals" (1910), "On the Structure and Relations of Notharctus, an American Eocene Primate" (1919), "The Origin and Evolution of the Human Dentition" (1922).

Major B. F. S. BADEN-POWELL was educated at he Charterhouse. Early interested in aeronautics, he devised man-lifting kites. He is a past honorary ecretary and past president of the Aeronautical Society, n institution which owes much to his energies in days gone by.

Sir A. SMITH WOODWARD, the well-known geologist, was born at Macclesfield, and educated at Manchester Grammar School and Owens College. Entering the Natural History Department of the British Museum n 1882, he attained finally the Keepership of the geological section. Sir Arthur is a past president of the Geological Society, and of the Linnean Society. n 1917 he was a Royal medallist of the Royal ociety.

Societies and Academies.

LONDON.

Geological Society, April 21.—**L. R. Cox**: *Anthracopupa britannica* sp. nov., a land gastropod from the Keele beds of Northern Worcestershire. The occurrence is recorded, for the first time, of a pulmonate gastropod in British Carboniferous rocks. The specimens were collected by Mr. W. Wickham King in 1924 from a grey calcareous claystone, interstratified with the vermilion marls of the lower part of the Keele beds, on the northern slope of Clent Hill. One species is a land shell, referable to the family Pupillidæ; it is very close to *Anthracopupa vermilionensis* (Bradley), from the Coal Measures of Illinois, but is slightly stouter, and differs in detail.—**H. P. Lewis**: On a rock-building bryozoan with phosphatised skeleton from the basal Arenig rocks of Ffestiniog (North Wales). The black, usually ovoid masses in the basal Arenig rocks (Garth Grit) on both sides of the Harlech Dome, have been designated 'lumps,' 'pebbles,' and 'nodules.' On the evidence of etched surfaces and microscope-sections, the structure of these masses is found to be originally organic, but modified later by inorganic processes. A new genus of the Ceramoporidæ of Ulrich is described. It is represented by one species—the earliest bryozoan known in British rocks. It was responsible for the building-up of the nodular masses, which contain a large amount of calcium phosphate.—**C. A. Matley**: The geology of the Cayman Islands (British West Indies), and their relation to the Bartlett Trough. With an appendix on the species of Lepidocyclina and Carpenteria from Cayman Brac and their geological significance, by **T. W. Vaughan**. The Cayman Islands are an isolated group of three islands, with an area of 100 square miles, all very similar in their geological structure and history, although each is a separate faulted block. The islands are built entirely of calcareous rocks free from terrigenous materials other than fine dust. There are two formations present, an older Bluff Limestone, and a newer, Ironshore Formation, lying unconformably upon the former, which makes a coastal terrace with a maximum height of 12 to 15 feet above the sea. The Bluff Limestone, a white, massive, semicrystalline limestone, containing casts of mollusca, badly preserved corals, nullipores, and foraminifera, resembles lithologically many parts of the White Limestone of Jamaica. Cayman Brac is Middle Oligocene, while Little Cayman and Grand Cayman seem to be of Miocene age, not newer than Lower Miocene. On the coastal shelf formed round each island by marine erosion the calcareous Ironshore Formation, with its mollusca and corals of living species, was deposited. Its emergence, in Pleistocene or recent times, as a low platform backed by the ancient cliffs, is probably the result of a fall of sea-level. The almost completely submerged Cayman Ridge on which the islands stand, and the Bartlett Trough which flanks it on the south, are examined in the light of the Wegener hypothesis. The Ridge may once have lain near the Jamaica-Honduras Ridge, with Jamaica itself confronting the Sierra Maestra of Cuba; further, the separation has taken place by the development of a great crustal fissure (initiated probably in Pliocene, or at the earliest in Middle Miocene, times) which has become the Bartlett Trough.

PARIS.

Academy of Sciences, April 12.—**Paul Appell**: The arithmetical nature of Euler's constant.—**André Blondel**: Contribution to the theory of the musical singing arc.—**Léon Guillet**: The addition of nitrogen to ordinary and special steels. Superficial hardening of certain steels is produced by heating to about 500° C. in a current of ammonia. A study of this reaction, with special reference to the nature of the steel, shows that ordinary steels become fragile. Nickel steels give no increase in superficial hardness, but slight increases are shown by chrome steels, manganese steels, silicon steels. Remarkable increases are given by aluminium steels.—**Winogradsky**: The fixing power of soils (for nitrogen).—**Paul Vuillemin**: The family of the Sarcosporidia.—**Bertrand Gambier**: The deformation of tetrahedral surfaces, with conservation of a conjugated network and rigidity of an asymptotic.—**Miécislas Biernacki**: A theorem of M. Denjoy.—**Julius Wolff**: A generalisation of a theorem of Schwarz.—**Ernest Esclangon**: The mechanical and optical asymmetry of space in respect to the absolute movement of the earth.—**R. Baticle**: A solution of the problem of a wall sustaining a powdered mass.—**Turpain** and **Bony de Lavergne**: Experiments on the Magnus effect.—**A. Dauvillier**: The nature of soft X-rays. A discussion of the causes of the differences between the experimental results of the author and Holweck.—**Francis Perrin**: The fluorescence of long duration of salts of uranium, solid and in solution. Experiments confirming the view that the luminescence of uranium salts is a fluorescence of long duration, analogous with the short fluorescence of certain colouring matters, such as fluorescine.—**Ch. Courtot** and **C. Pomonis**: Researches on diphenylene sulphide. A development of the most probable formula for the diaminodiphenylene sulphide described in a previous communication.—**A. Demay**: The cristallophyllian stratigraphy of the Pilatus massif near Saint-Étienne.—**Paul Corbin** and **Nicolas Oulianoff**: The elements of the two tectonics, hercynian and alpine, observable in the protogine of Mont Blanc.—**Michel-Durand**: The solvents for tannins. The tannins soluble in alcohol or in acetone are also soluble in water, and the use of these liquids in succession for extraction, even including ether, gives no higher yield than hot water.—**Th. Kraschenninnikoff**: The gaseous exchanges of the brown algæ of the Arctic region exposed at low tide. In the Arctic region (island of Kildine) in algæ exposed to the air at low tide, there is very energetic assimilation, which, under good lighting conditions, is much more intense than the respiration, resulting in the formation of large quantities of organic material.—**Émile F. Terroine** and **R. Bonnet**: The causes of the specific dynamic action of the proteids.—**E. Fleurent**: The composition of the seed of fenugreek and its admixture with wheat intended for milling. The presence of fenugreek seeds in wheat, owing to the objectionable smell of its essential oil and bitter taste of its resin, renders flour made from such wheat unsuitable for bread-making. Even such a small proportion as ¼th per cent. of fenugreek seeds can be tasted in the bread.—**Constantino Gorini**: The action of streptococci on milk.

Official Publications Received.

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 40: Statistics of Public High Schools, 1923–1924. Pp. 33. 5 cents. Bulletin, 1926, No. 1: Educational Directory, 1926. Pp. iii+129. 20 cents. Bulletin, 1924, No. 14: Biennial Survey of Education, 1920–1922. In 2 vols. Vol. 2. Pp. iii+763. (Washington, D.C.: Government Printing Office.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Lucia, 1924. Pp. iv+30. (Trinidad, B.W.I.) 6d.

Report of the Kodaikanal Observatory for the Year 1925. Pp. 4. (Madras: Government Press, 1926.) 6 annas.

Annual Report of the Council of the Yorkshire Philosophical Society for the Year 1925, presented to the Annual Meeting, February 8th, 1926. Pp. 37+21+7 plates. (York.)

Diary of Societies.

SATURDAY, May 15.

Royal Institution of Great Britain, at 3.—Dr. G. C. Simpson: Atmospheric Electricity (1).

MONDAY, May 17.

Royal Geographical Society (at Lowther Lodge), at 5.—Dr. F. Dixey: The Nyasaland Section of the Great Rift Valley.

Royal Institute of British Architects, at 8.

Aristotelian Society (at University of London Club), at 8.—Symposium.

Eugenics Education Society (at Royal Society), at 8.30.—W. T. J. Gun: Foundations of Notable Families.

TUESDAY, May 18.

Royal Statistical Society (at Royal Society of Arts), at 5.15.

Royal Society of Medicine, at 5.30.—General Meeting.

Royal Anthropological Institute, at 8.30.—M. Terry: Some Little Studied Aborigines Encountered during Travels in North Australia.

WEDNESDAY, May 19.

Correlative Science Society (at Royal Botanic Society of London), at 8.—Conference on Energy, Kinetic and Potential. The Stupendous Energy of Cosmic Speed: Exploding Suns.

Royal Meteorological Society, at 5.—H. S. Player: Meteorological Conditions and Sound Transmission.—Dr. J. Glasspoole: The Wet Summer of 1924 and other Wet Seasons in the British Isles.—C. E. P. Brooks: Pressure Distributions associated with Wet Seasons in the British Isles.

Royal Society of Medicine (History of Medicine Section) (Annual General Meeting), at 5.—W. G. Spencer: Celsus: De Medicina—a Learned and Experienced Practitioner of Medicine, upon what the Art could then accomplish.

Geological Society of London, at 5.30.—Mrs. Jane Longstaff: A Revision of the British Carboniferous Murchisoniidæ, with Notes on their Distribution and Descriptions of some New Species.—T. Neville George: The Carboniferous Limestone (Avonian) Succession of a Portion of the North Crop of the South Wales Coalfield.

Institution of Electrical Engineers (Wireless Section), at 6.—M. Thompson, R. H. Dudderidge, and J. G. A. Sims: Life-Testing of Small Thermionic Valves.

Institute of Metals (at Institution of Mechanical Engineers), at 8.—Prof. H. C. H. Carpenter: Single Metallic Crystals and their Properties (May Lecture).

Society of Glass Technology (in London).

THURSDAY, May 20.

Royal Society, at 4.30.—Prof. A. V. Hill: The Laws of Muscular Motion (Croonian Lecture).

Royal Society of Medicine (Dermatology Section) (Annual General Meeting), at 5.—Dr. H. C. Semon: Case for Diagnosis.—Dr. Kingston: Premycotic Stage of Mycosis Fungoides.—Dr. H. W. Barber: Reticulated Pigmented Poikiloderma (Civatte).

Institute of Pathology and Research (St. Mary's Hospital, W.), at 5.—Prof. J. Mellanby: The Mechanism of Pancreatic Secretion.

Royal Institution of Great Britain, at 5.15.—N. R. Evans: Corrosion, Tarnishing, and Tinting of Metals (1).

Chemical Society, at 8.

Röntgen Society (and Royal Society of Medicine—Electro-Therapeutics Section) (at Royal Society of Medicine), at 8.15.—Dr. A. Dauvillier: The Measurement of X-ray Dosage (Mackenzie Davidson Memorial Lecture).

FRIDAY, May 21.

Royal Society of Medicine (Electro-Therapeutics Section) (Annual General Meeting), at 5.30.—Dr. H. Eaton Stewart: Diathermy in Pneumonia.

Photomicrographic Society (at 4 Fetter Lane), at 7.—Annual Exhibition.

Royal Institution of Great Britain, at 9.—J. E. Pearce, Jr.: Recent Developments in the Art of Fine Measurements.

PUBLIC LECTURES.

MONDAY, May 17.

King's College, at 5.30.—Dr. C. D. Broad: The Present Position of the Logic of Induction.

WEDNESDAY, May 19.

Gresham College, at 6.—A. R. Hinks: Astronomy. (Succeeding Lectures on May 20 and 21.)

CONGRESSES.

May 15.

Institute of Transport (at Birmingham).

May 22 to June 2.

Italian National Congress of Pure and Applied Chemistry (at Palermo).

May 24, etc.

International Geological Congress (at Madrid).

May 24 to 29.

International Ornithological Congress (at Copenhagen).

May 25.

International Society for the Protection of Childhood (at Rome).

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Hours, Wages, and Welfare in Industry.

OF all the problems which have been left to Great Britain as a legacy of the War, that of unemployment has proved to be the most tragic, most persistent, and most intractable. Ever since the short-lived boom of 1919 the nation has had to contemplate week by week the spectre of anything from 1 to 2 million workers unemployed. Although the anxiety arising from this fact has been alleviated in some degree by the knowledge of the relief arising from the operation of the Unemployment Insurance Act, it is to our credit as a nation that we have never ceased to concentrate attention on remedies for this evil as well as on palliatives of its worst defects. Private investigators have inquired carefully and scrupulously into the effects of unemployment, and official analyses of the unemployed have been made in order to get so far as possible to the tenacious, deep-seated roots of the trouble.

It was not, therefore, surprising that when the first Labour Government came into power it should follow the excellent British tradition of appointing a committee to inquire into the conditions and prospects of British industry and commerce, with special reference to the export trade. Accordingly, the Committee on Industry and Trade was set up by Mr. MacDonald on July 28, 1924, with a distinguished and impartial personnel ranging from members responsible for the conduct of large industrial undertakings, with economic experts and the chief economic adviser to the Government, to representatives of the wage-earners As is the British custom also, the political colour of the Commission was blended in a judicious pattern. In a memorandum accompanying the terms of reference, the Committee was asked to direct its attention first to the position of British Overseas Trade and the prospect of British participation in the markets of the world. In pursuance of this request, the Committee issued in July 1925 a first volume entitled "Survey of Overseas Markets," in which it surveyed Overseas trade and brought together in a convenient and accessible form a mass of valuable data upon that subject.

Another of the three questions put up to the Committee in the memorandum referred to was that of the relations between those engaged in production. In the words of the memorandum, "This will involve inquiry into methods of industrial remuneration, the main causes of unrest and disputes, and the methods of avoidance or settlement of disputes, as, for example, co-partnership, co-operation, wages boards and voluntary arbitration, State regulation of wages, and compulsory arbitration and compulsory enforcement and extension of agreements."

Faithful to this term of reference, the Committee has now produced a second volume,[1] which covers the ground indicated by our quotation. The main part of the book consists of six chapters on population, wages, conditions of labour, unemployment, machinery for industrial negotiation, and statistical data respectively. As the terms of reference required the Committee to have special regard to the export trade, the investigations were limited to those industries which account for the major part of exports of British manufactures, namely, coal mining, iron and steel, engineering and shipbuilding, electrical manufacturing, cotton, woollens and worsted, chemicals, and clothing. The information in the six chapters referred to has, of course, been mainly supplied by the Government Departments concerned. Upon the Registrar-General fell the labour of providing statistics as to population; the rest of the burden was mainly carried by the Ministry of Labour, the Mines Department, the Board of Trade, and the Home Office. In what is termed an introduction, of 53 pages in length—practically a review of the mass of the information gathered—the Committee surveys the field of labour and brings out the principal facts and tendencies. The keynote of this survey is to be found in the statement that "the primary objects of this volume are descriptive throughout and no systematic attempt has been made therein to trace and co-ordinate the underlying causes of the phenomena described, still less to formulate conclusions as to remedial measures."

The publication of the volume rests upon the Committee's belief "that the impartial ascertainment and publication of authoritative data on certain essential aspects of industrial relations in Great Britain will not only be of value to a large number of persons who desire a trustworthy book of reference, but will also conduce towards the better understanding of present-day economic problems, both by limiting the field of controversy and by facilitating and clarifying discussion." To the constant student of economics, therefore, this volume brings little added knowledge. It is a praiseworthy book of reference, but little more. Nevertheless, on that account alone its value is not to be denied. We may therefore with advantage pick out some of the principal facts established in order the better to equip ourselves in our consideration of the industrial problems which Great Britain has yet to solve.

Although it is customary to speak of four agents of production, namely, land, capital, labour, and organising ability, in the ultimate analysis, all is seen to depen upon the productivity of human effort. Land i limited in quantity, and has its own degrees of fertility Capital is itself the fruit of productivity, stored up i quasi-permanent form. The free gifts of Nature, th sunshine and the rain, are beyond human choice c control. Labour therefore, excluding for the preser its small but important sub-class of organising ability is of supreme importance to the Committee on Industr and Trade. The growth and distribution of th population thus naturally receives first attention i this report.

During the decade from 1911 to 1921, containin the War years, the increase of population in Grea Britain was less than 2 millions, or scarcely mo than half of that of the preceding decade from 1901 t 1911. This figure, of course, includes children, wive and others who followed no industrial occupation, an omitting this, the War decade showed an increase i the number of occupied persons, whether employe or employees, of just over a million. But the Wa with its heavy loss of adult male lives, left its mar in the altered distribution by ages of the occupie population. Practically the whole of the millio increase referred to took place in the older-age group those above 45 years. This decline in the proportio of workers of the most efficient ages cannot be ove looked in weighing the degree of productivity availab to industry, and the Committee, in noting this fac points out also that future years are likely to sho this factor of disadvantage in an increasing degre Britain has thus two million more mouths to fee with one million more workers, but the producti efficiency of the working population as a whole mu be taken to have been diminished, though but slightl by the heavier proportion of workers in the older-a groups. Here is one definite result of the War, whi is not likely to be remedied by natural events for ma years. To offset it, one must look largely to improv ments in industrial organisation.

Another striking problem which has remained to from the War is the mal-distribution of the worke among the industries. Statistics on a comparab basis for 1911 and 1921 are available for England a Wales only. Speaking in terms of percentages of th number of occupied persons, we notice that for agr culture the figure has fallen between 1911 and 19 from 7·55 to 6·54 per cent., for the manufacture clothing (including boots and shoes) from 6·45 to 4· per cent., and for building, decorating, and contracti from 5·29 to 4·42 per cent. To those who ha followed the history in recent years of agricultu economics, the fall in this industry will come as surprise. But the Committee on Trade and Indust not concerned with this, and the absence of any mment is not surprising. We had, however, expected me comments on the two other decreases we have entioned. Perhaps it is assumed, and rightly, that e public is already sufficiently aware of the difficulties providing the additional labour in the building industry. But what is the reason for the fall in the number f persons occupied in manufacturing clothing? We ave two million more to clothe, yet the percentage of orkers engaged has decreased by more than 25 per cent.

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[1] "Committee on Industry and Trade. Survey of Industrial Relations Based on Material mainly derived from Official Sources, with regard to Industrial Remuneration, Conditions and Relationships in Great Britain and certain other Countries so far as available, together with Statistical Tables." With an Introduction by the Committee. Pp. v+497. (London: H.M. Stationery Office, 1926.) 5s. net.

It is not, however, so much the decreases as the creases in various industries which invite attention. oal mining in 1921 occupied 6·59 per cent. of the cupied population, compared with 5·96 per cent. in 11. Here, again, the Committee rightly assumes that tle comment is needed. In the chemical and paint dustry the percentage has risen from 0·81 to 1·15, striking increase. In metals, machines, implements d conveyances, the increase is from 9·31 to 12·37 r cent. The Committee is content to record these cts. We should have welcomed some exploration of eir causes, their effects, and the possibility of some elioration of the economic disadvantages to which ey have given rise. How far, for example, are the nt Restriction Acts, with their paralysing effect on bility, to be saddled with the responsibility for the rsistence of these abnormalities? At a later stage the introduction, the Committee discusses the lation between sheltered and unsheltered trades, but is important fact of supply is not brought into the ena. It is considered that the prime difference tween sheltered and unsheltered trades depends on e element of time. From that we must dissent. regards the relation of these facts also to unployment, the Committee is content to state that does not deal with the large problem of the mobility labour, because there are no official data enabling cumulative effect to be estimated.

After treating of population, the Committee turns the kernel of this part of the terms of reference, d deals with wages and earnings. As is pointed t, on this subject there is the view of the emyer and the view of the worker. To the former, e governing consideration is the amount of earnings r unit of output; to the latter, the primary conderation is the total quantity of necessary or desirable mmodities which he can purchase with his weekly rnings. The necessity of distinguishing, so far as acticable, between wages as an item of cost and as means of livelihood is therefore emphasised. Here ain we are faced with the lamentable paucity of icial statistics. There has been no comprehensive vey of wages since the partial inquiry of 1906; re has been no effective census of production since 1907; there has been no adequate inquiry into the household budgets of the workers since 1904. In the present year we may hope to have the results of official inquiries in the first two of these fields; as for the third, we must still possess ourselves in patience. The Committee records, therefore, that it is compelled to resort to imperfect methods of estimate.

From the slender information available, the Committee concludes that the net rise in money wages per week on the whole averages between 70 and 75 per cent., but that, first, the proportionate rise has been greater for the less skilled than for the more highly skilled workers; and secondly, the proportionate rise has been less for industries directly exposed to the blast of foreign competition than for those which are less exposed to that competition. As already mentioned, it is the real cost of labour with which the employer is concerned, and the Committee therefore proceeds to examine this aspect of the question. Since the index number of wholesale prices for 1924 was about 66 per cent. higher than its pre-War level, it follows that, *ceteris paribus*, there has been, on the average, a small increase in real wages, and therefore a small increase in the wages element in the real cost of production. But here again there is the same condition of unequal distribution between the sheltered and unsheltered industries, or unexposed and exposed industries, as the Committee prefers to call them.

The reliability of these conclusions is, however, somewhat weakened by the fact, pointed out by the Committee, that everything depends upon the *ceteris paribus*. If other factors have not remained constant, if the efficiency of labour or of industrial organisation, for example, has varied, then some of this reasoning must be revised. The Committee therefore postpones its final conclusions until the results of the evidence it is taking and of its own special investigations can be reviewed. When this point is reached we may hope the fallacy of averages will be borne in mind, and that the Committee will be content with recognised lines of statistical technique.

From the point of view of the worker, concentrating on the purchasing power of his weekly wages, the cost of living index must be substituted for the index of wholesale prices. As the mean of the monthly numbers for that index was 75 per cent. above the pre-War figure, the Committee notes that, again on the average, there was little if any change in real wages to the worker, but that the same disproportionate distribution appears between skilled and unskilled men, between sheltered and unsheltered trades. The validity of all these conclusions is, however, impaired by the limitations to which the evidence on which they are based is subject. It is stated, for example, that "the information at the disposal of the Ministry of Labour is insufficient to enable the average percentage increase for all industries and occupations to be computed with precision, but it is estimated. . . ." Again, "No information is available, however, as to changes which have occurred in rates of wages in industries, or sections of industries, in which neither standard nor minimum rates, nor the general amount of increase or decrease in rates of wages, have been fixed by collective agreements, arbitration awards, Statutory Orders, etc." And finally, "No corresponding figures [of pre-War and 1925 wages] can be given as regards the earnings of piece-workers, who form a large proportion of the skilled work-people in many of the principal export trades."

We do not wish to dwell too strongly on these defects, but that there may be a substantial difference between estimates based on rates of wages and facts as to actual earnings is shown, on the one hand, by the inclusion of skilled engineers in a table under the heading of "Increases substantially below the general average," and on the other hand, by the definite statement, based on statistics furnished by the Engineering Employers' Federation, that for engineering workers, skilled and unskilled, the general average rise of money earnings was about 73 per cent. when working on piece, and 65 per cent. when working on time, or taking both together, and including the shift over from time to piece which has taken place since 1914, an increase of 73 per cent. This compares with the 75 per cent. increase in the cost of living. As we are also told that piece-work is widely prevalent in the textile, mining, iron and steel and clothing groups, but that time work is still much the more usual method in the engineering and kindred trades (despite the tendency to change from time to piece), we begin to have some doubts whether the difference between sheltered and unsheltered industries is so clean-cut and definite as the Committee's report suggests.

We have only space to mention some of the other topics of absorbing interest brought together in this survey. There are interesting tables of the movements of real wages in other countries, but the impossibility of relating different national standards of living, to say nothing of the incomparability of national methods of calculating the movements in the cost of living, robs them of much value. Comprehensive particulars are here brought together of changes in hours of labour, welfare work, unemployment, conciliation and arbitration machinery, all relevant to the problems of industry to-day. We notice, for example, that the time lost through sickness amounted in 1924 to more than 26 million weeks, or more than eighteen times the number of weeks (1·4 million) lost through trade disputes in the same year. Yet there are many wh deem national expenditure on health and welfare worl a waste of money.

Every thoughtful student of national well-being mus be very grateful to the Committee on Trade an Industry for this publication. We may perhaps b permitted also to include in this recognition of worl well done all the labour which fell upon the Governmen Departments concerned. Two-thirds of the Committee' task has been accomplished, but the greater part stil remains. The productive capacity and organisatio of British industry, the supply and efficiency of capita labour and management, the present extent of larg scale production, its possibilities and limitations, th current methods of industrial and commercial financ etc., have yet to be investigated. In this sphere, anywhere, the Committee must come to real grips wit its problem, namely, the root causes of the depressio of the coal, iron and steel, textile and other industrie which have steadily lost ground in the last seven year We look forward eagerly to the remaining volume, which the Committee will deal with these baffli problems, and on which the justification for its appoin ment and labours will be almost entirely judged.

W. H. COATES.

Avian Migration.

Problems of Bird-Migration. By Dr. A. Landsborou Thomson. Pp. xv+350. (London: H. F. a G. Witherby, 1926.) 18*s*. net.

THE study of avian migration has been elevat to a higher scientific plane than heretofore Dr. Landsborough Thomson in the book under revie The phenomenon of migration has at all times been secret of absorbing interest and speculation not on among scientific men but also among those whose hob has been of a scientific nature. As a means where evidence can be collected to assist the biologist and help solve the larger biological problems, a valua source can be found in avian migration, now that importance has been recognised. "To study t migration of birds is to investigate the nature of anin behaviour, and to do this is to probe the inn mysteries and to ask the very meaning of L itself" (p. 327).

The book is unsatisfactory in the sense that it fa to satisfy, but at the same time it completes the pictu in as thorough a manner as our present knowledge w permit. A creditable, over-cautious strain permea the whole book, which is delightfully free from dogma or fanciful theories.

Part I. summarises all known facts bearing on t subject, serving as an excellent basis for further inves gations. Part II. specialises in individual migration with special reference to the results of bird-marking. Part III., which deals with the main complex problems of bird migration, stands out as the most important part of the book, giving much food for thought and many lines for further investigation. In the past, avian migration has been studied as a whole, theories being frequently built up to fit in with existing evidence, which, to say the least of it, has been fragmentary. In the first place, migration is not a phenomenon confined to birds alone, and, if the secret is to be probed, some knowledge must be gained of the migrations of fishes, insects, and mammals. The periodic transfer of residence is identical in many branches of life, though probably the stimuli and initial causes are widely different.

It appears to the writer that the correct study of the larger problems of migration is to examine in closest detail the movements not only of single species but also of individual communities among birds; and indeed, as one can now do with the aid of bird-marking, the movements of the individual bird itself.

Assuming for the moment that both the Darwinian and Mendelian principles express truths on evolution, and that the making of the species in some cases follows one, sometimes the other, and sometimes a combination or modification of both or either, can we not apply such doctrines to a problem such as migration? Avian migration as witnessed to-day, ranging, in the case of some high-level birds, from a simple altitudinal move from alpine meadows to sheltered valley, to the vast periodic movement of other species from the Arctic to the Antarctic, have every degree of intermediate form, and the one could easily, as argued by Dr. Landsborough Thomson, spring from the other. Then we have what Dr. Thomson terms irregular migration phenomena (Chapter vii.). Birds which adopt this habit, dispensing with the slower Darwinian principle, perform in one bound an act which in other birds may have taken countless ages to evolve in its perfect shape.

No simple explanation, however, fits every case; hence the difficulty. The stimulus which sets free the desire to migrate may have a hundred variations. That the desire is deep-seated is beyond question, and it is difficult to believe that such a desire is not as much a part of the germ plasm as is the ability of birds of a species to build nests of remarkable similarity. Dangerous as are analogies to logic, nest building is as regular, as true to type, and as accurate in heritable qualities as is migration, and is probably subject to precisely the same laws of evolution as the formation of a species or of a geographical race.

It may be found, and probably Dr. Thomson would agree, that a particular migration route, or a particular stimulus which sets free the desire to migrate, or the particular means by which birds find their way on migration, will apply to a particular species or even a community within that species, and will not be true of others apparently carrying out a similar migration. This can only be verified by an intensive study of the species or individual. When that is complete it will be time enough to generalise and find out what influences are common or general.

In his last few chapters Dr. Thomson seems wilfully to tantalise his reader by nibbling at many by-products of migration. He bites into the much-vexed question of the inheritance of acquired characters. Perhaps space, perhaps mental digestion (or indigestion), forbade more than a bite. But one would have welcomed his views, as migration seems to offer such valuable evidence.

The home of the bird. The original centre of dispersion. Where is it? In many cases, such as the Petchora pipit (*Anthus gustavi*), *Acrocephalus griseldis* breeding in Iraq and wintering almost entirely in east tropical Africa, and *Irania gutturalis*, we find a winter quarters almost as restricted as the breeding quarters. Why again should certain species (*Apus a. pekinensis*, *Falco naumanni pekinensis*, and *Falco vespertinus amurensis*) travel to restricted winter quarters in South Africa? It is most unlikely that the amenities of South Africa were accidentally discovered, or even that such amenities do not exist at nearer ranges in south Asia or Africa. Why do many species travel from north Europe to south-east Asia every year, and others from north-eastern Asia to South Africa? There must be a meaning, and if we knew more about the original home of the bird a clue would be supplied.

Again, why should birds sometimes select a different return route in spring from their autumn route? In addition to the cases cited by Dr. Thomson, two races of the Willow warbler (*Phylloscopus trochilus trochilus* and *eversmanni*) pass through Egypt in autumn in countless thousands, but in spring their occurrence is a great rarity, though in Palestine they occur in spring almost as commonly as they occur in autumn.

The ability of birds to find their way on dark nights and over great distances without the aid of landmarks is perhaps as complex a problem as exists in the whole story of migration, and no attempt will be made here to fathom such a fascinating subject beyond quoting a curious experiment undertaken by the writer near Karachi in 1913.

A night was spent on a sandy beach where the Loggerhead turtle was known to breed, and at a time of year when the young should be emerging from their sandy nests. Both sea and wind were dead calm. On the south side of the beach was the open Indian Ocean. To the north was a deep, wide lagoon, only connected with the sea at high tide. Young turtles do not all emerge from their sandy nest in a bunch, but do go singly or in small parties, and a few early ones give one warning of the general hatching. Two active nests were located, and in each case the sloping beach was levelled and a sand parapet erected four feet from the nest in order to prevent slope of terrain or sight of sea acting as hints in direction to the babies. The first nest gave its young to the world with the earliest blush of dawn, the second nest after sunrise but before the sunlight bathed the beach, a tall belt of palms screening the rays. In eleven observed cases out of a total of nineteen, the babies scuttled towards the open sea, over our parapet, and into the ocean without a moment's hesitation. In the other eight cases there was slight hesitation, which seemed due more to daze than to uncertainty. The slight traces of those baby flippers on the sand were obliterated by our party as soon as they were formed. In this case the roar of the surf, the smell of the ocean, wind, sight, and slope of ground were eliminated so far as one could, and yet these babies, but a few minutes old, acted without undue hesitation and apparently certain knowledge. It is indeed difficult to deny the existence of inherited knowledge based on ages of experience.

The young cuckoo, and many other birds, set out every autumn at the appointed time on a definite journey with a definite object, without apparent guidance. Instinct is a lazy and meaningless explanation. Science requires something more exact, based on evidence. But it is to instinct we would address the question: Why?

There is one biological aspect of migration to which we had wished Dr. Thomson had addressed himself. He does not touch on the influence of migration on power of flight and evolution. Is there such an influence? Must we accept the old dogma that migratory birds have wings more suited to migration than others which are resident? Are we to believe that a mere incident in a bird's life (all-important though it be) will influence structure?

Dr. Thomson has taken us all up one rung of the ladder in a book where simplicity, logic, and science go hand in hand. As a book of educational value, or as a reference book, the work is unique. It has summarised, modernised, and, so far as existing evidence allows, helped to elucidate problems of immense scientific import. Migration has at last received the attention it has deserved at the hands of a trained scientific brain and has been lifted up from the plane of conjecture and spasmodic research to that of sound logic and scientific analysis.

Surveying.

(1) *Text-Book of Topographical and Geographical Surveying.* Edited by Col. Sir Charles Close and Col. H. St. J. L. Winterbotham. Third edition. Pp. iv+366. (London: H.M. Stationery Office, 1925.) 15*s.* net.

(2) *Surveying Instruments: their Design, Construction, Testing and Adjustment.* By R. M. Abraham. Pp. ix+309. (London: C. F. Casella and Co., Ltd., 1926.) 7*s.* 6*d.* net.

(3) *Surveying for Everyone.* By A. Francon Williams. Pp. 114. (London: The Sheldon Press; New York and Toronto: The Macmillan Co., 1925.) 3*s.* 6*d.* net.

(1) THE "Text-Book of Topographical and Geographical Surveying" embodies the experience of surveyors who have carried out surveys in most parts of the British Empire, and under very varied conditions. Each method, or process, included in the book has been tested and used with success, and is described by a writer who has employed it. The book has therefore gained the confidence of practical surveyors. The second edition having been out-of-print for some months, the appearance of the third edition has been eagerly awaited, and will be warmly welcomed.

The third edition is the same size as the second, but the type is a little smaller, so that more information is contained in the same space. The price has been doubled, but the book is still good value.

Much new information has been added, but few alterations or corrections have been found necessary in the original matter. There are three new chapters dealing with surveys in war, photographic surveying, and the prismatic astrolabe. The chapters on surveys in war and photographic surveying are necessarily little more than introductions to large subjects. The prismatic astrolabe is an instrument which is likely to be used, in conjunction with radio time signals, for the determination of astronomical longitudes. A clear account is given of the methods of using it, and reducing the observations. A new section dealing with the reception of radio time signals is a valuable addition to the book. Another new section is devoted to Prof. Jeffcolt's direct-reading tachymeter.

The most important change that has been made in the original matter is the substitution of the mid-latitude formula for computing geographical latitudes, longitudes and reverse azimuths for Puissant's method. The computations involved are simpler, and the results not less accurate.

In a book which contains so much information, it is perhaps unfair to search for omissions, but space might perhaps have been found for a description of the Transverse Mercator projection, which is recommended for war maps, and may be adopted for the small scale maps of the Ordnance Survey. The elimination of distortion in field sheets, by pasting them on to a thin sheet of aluminium or zinc, before mounting them on a plane-table, might also have been mentioned, as this is likely to become the standard practice.

The book deals, in a clear and practical way, with every important problem that is likely to confront a surveyor. It is an excellent example of how a textbook should be written.

(2) In the past, surveyors have often been handicapped by a lack of knowledge of the first principles of optics and instrumental design, with the result that they have not been able to make the best use of their instruments, or competent to suggest improvements in the design of them. "Surveying Instruments" gives a clear and concise account of every instrument used by the surveyor, and an analysis of most of the instrumental errors which may be expected. It is a book which should be consulted by every surveyor who wishes to use his instruments to the best advantage, and it is to be hoped that it will establish a closer liaison between the surveyor and the instrument maker. On the other hand, the instrument designer should remember that the way to test his instruments is to observe with them on a cold, dark, windy day. If the instrument stands steady in the wind, if all the necessary adjustments can be made with frozen fingers, and the required observations made in dull light and without any uncertainty, the instrument will earn the surveyor's confidence. But if it fails in any of these respects, he will probably discard it for another, which, though less accurate, is better adapted to field work.

It is probable that in the most accurate modern instruments the errors of observation are largely due to varying and unequal illumination of the field of the micrometer microscopes. This is a point that deserves the attention of the instrument designer. The Wild theodolite, recently designed and manufactured in Switzerland, is arousing much interest amongst surveyors, and it is to be hoped that British instrument makers will study, and test, the new methods and principles incorporated in this instrument.

An account might perhaps have been given of the 'constant bubble' spirit level, and of the latest pattern of geodetic levelling staff as used on the Ordnance Survey.

(3) This is a small handbook designed for the instruction of those who have no knowledge of surveying, and whose mathematical knowledge is limited to simple arithmetic. It describes in simple language how a survey of a small area may be made with a chain, a plane-table, or a prismatic compass. The computation of areas, contouring, and scales are also dealt with.

The Manufacture of Sugar.

Sugar. By Geoffrey Fairrie. Pp. xiv + 233 + 62 plates. (Liverpool: Fairrie and Co., Ltd., 1925.) 12*s.* 6*d.* net.

SUGAR, the sucrose of the chemist, is very widely disseminated in the vegetable kingdom, where in many plants it forms the most important carbohydrate reserve substance. Originally consumed as a condiment, or even taken as a medicine, it has during the last few centuries become one of the most important articles of dietary among the nations of the world. Great Britain, which next to the United States is the largest sugar-consuming country in the world, consumes sugar in different forms at the rate of more than 90 lb. *per capita* per annum. The two chief sources of sugar are the sugar-cane, *Saccharum officinarum*, and the sugar-beet, *Beta vulgaris*, whilst sorghum, maple, and palm occupy subsidiary positions.

In view of the importance of sugar as a food material, a book on the subject of its manufacture, which enables the general public to understand how it is extracted from plants, and how it is refined into a product fit for consumption, should be welcomed. The author of the work before us states that his object has been to present general information on the subject of sugar in such a form that it can be understood by the laity. But far more than this has been done. The author has produced a book not only for the laity, but one which, in many parts, may also be studied with advantage by the intending technician. At the present time the technology of sugar manufacture has increased in importance in Great Britain, in view of the rapidly developing beet-sugar industry.

Pure science is touched on in this work to a slight extent, and most of the information given is of a 'scrappy' character. The object of the book is, however, to deal with the practical side of the subjects, and it contains a complete description of the manufacture of sugar from cane and beet, giving illustrations of the plant employed. The diagrams giving the general arrangement of plant in a cane-sugar and beet-sugar factory are particularly instructive. The separate plant employed, vacuum pans, centrifugal machines, etc., are clearly described both in the text and by illustrations. Some space is devoted to decolorising charcoal and carbons—their method of preparation and use. The physiology of sugar is dealt with, and finally the analysis of sugar by the polarimetric method is described.

We cordially commend this work, not only to the general public, but also to those scientific men, chemists, engineers, etc., who desire to obtain a succinct account of the manufacture and refining of sugar.

ARTHUR R. LING.

communicating to those that seek their aid only such information as is based on accepted fact. The monograph may indeed be recommended as a model for those who seek to gain the sympathetic understanding of the community they serve and thus to secure for their science further opportunity.

Electrical Photometry and Illumination: a Treatise on Light and its Distribution, Photometric Apparatus and Illuminating Engineering. Pp. xvi+427. By Prof. Hermann Bohle. (London: Charles Griffin and Co., Ltd., 1925.) 25*s.* net.

THIS second edition of Prof. Bohle's work is considerably revised and extended and is much more complete than his original treatise, which was based on lectures delivered at the University of Cape Town. The opening chapters follow the now familiar order, and are well adapted for the use of students. Chap. i. deals with photometric quantities, Chap. ii. with radiation and its effects. Subsequent chapters deal with the eye, photometric apparatus, the testing of electric lamps, shades, globes and reflectors, and illuminating engineering in general. The sections on photometric apparatus and the testing of electric lamps and illumination are exceptionally full.

Throughout the book the author shows himself conversant with recent work in Great Britain and the United States, though the illumination-photometers described appear to be mainly German and American, and the most recent British models of the lumeter and luxometer type seem to have been overlooked. The final chapters deal with practical problems, such as the lighting of schools, libraries, churches, theatres, etc., and there is a special section on industrial lighting. We notice that a reference is made to the first report of the Home Office Departmental Committee on lighting in factories and workshops. In a further edition some account might be given of subsequent reports and of the contents of American codes.

The book contains some effective illustrations, including a number originally presented before the Illuminating Engineering Society in England. Whilst the title conveys that the work is devoted to *electric* lighting, it might be advisable to include some reference to natural lighting, as comparisons of conditions by natural and artificial light are helpful to the student. At the end of the book there is a useful bibliography and an adequate index.

Geology of India: for Students. By D. N. Wadia. Second edition. Pp. xx+400+20 plates. (London: Macmillan and Co., Ltd., 1926.) 18*s.* net.

THE second edition of this work follows closely on the lines of the first, and, by the use of small type for details and subsidiary matter, the bulk has not been increased, in spite of the additions needed to bring it up-to-date. In a book which, in less than 400 pages of text, covers the whole ground of the geology, both pure and applied, of a region so extensive as the Indian Empire, the information must at times be pemmicanised, but in any criticism it must be remembered that one purpose of the book is to provide students with answers to examination questions. For the rest, the judgment passed in our review of the first edition might be repeated almost word for word; the general commendation remains as true as the criticism of certain passages which remain almost unaltered.

An outsider may marvel at the confidence with which the unfossiliferous, presumably pre-Cambrian, rocks of widely separated regions are correlated, and it is surprising to find that the great valleys of the Himalayas are still unhesitatingly accepted as examples of antecedent drainage. At the outset stress is laid on the time-honoured distinction between the peninsular and extra-peninsular regions of India; in this the author follows earlier writers, and will doubtless be followed by later, though the advance of knowledge has shown that the distinction, true enough as regards existing geography, is, when applied to geology, merely a partial view of one aspect of a many-sided problem. Yet with all this the book remains a useful one, and the only one of its sort at present available.

A Treatise on Hydromechanics. By Dr. W. H. Besant and A. S. Ramsey. Part 1: Hydrostatics. Ninth edition (revised). Pp. viii+136. (London: G. Bell and Sons, Ltd., 1925.) 7*s.* 6*d.* net.

"BESANT and Ramsey" is a classic, and has been so for several generations of students. It is, therefore, of some considerable interest that this—the ninth—edition should be very appreciably modified on production. It is not stated in the preface that these alterations are the result of any changed outlook by the author on the scope of the work or on the manner of presentation. The abolition of the order of merit in the Tripos makes it no longer profitable for the average student to devote much of his time to hydrostatics or to the solution of elaborate problems. In conformity with this, a substantial amount of the book work in previous editions has been omitted, along with numerous examples. We do not think the book has suffered from this at all; on the contrary, it has probably become much more readable to a larger number of students, for whom the parts that are essential have been retained. It is, however, an interesting illustration of how the examination system practically decides the text-book, and the text-book the teaching.

Wire-Drawing and the Cold Working of Steel. By A. T. Adam. Pp. 212. (London: H. F. and G. Witherby, 1925.) 40*s.* net.

THE author of this work, being on the research staff of a manufacturer's laboratory, is in a position to put into book form much valuable information on the subject of the wire-drawing and cold working of steel. The main object of the book is to explain the nature of wire-drawing and other cold-worked processes, and little attention is given to actual manufacturing methods except in so far as they are relevant to the main purpose of the book. The various scientific aspects of the subject are treated from a practical viewpoint, and not the least interesting chapters are those devoted to theories of plastic flow in cold-worked metals and to what the author calls the "pathological aspect of cold-worked operations." Judging from the large number of references given at the ends of the various chapters, the author, in addition to giving the benefit of his own practical experience, has done a service to metallurgical science in having included so much scattered information in a book of this kind.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Distribution of Freshwater Fishes.

As a mere sciolist in geology it sometimes occurs to me to wonder whether enough attention has been given to the distribution of freshwater fauna in estimating the origin of British land contours and the course of rivers. It is generally accepted that until the North Sea was formed by an extensive subsidence of land in an age not geologically remote, all eastward-flowing rivers south of and including the Yorkshire Ouse were tributaries of the Rhine. The natural result of this should be that the fishes of the Rhine should continue to inhabit its ancient tributaries, as in fact they do in all rivers between and including the Ouse of Norfolk, the Ouse of Yorkshire, and the Trent system. But there is a notable absence from the Thames and the Medway of two species common to the aforesaid rivers and the Rhine—namely, the burbot or eel-pout (*Lota vulgaris*) and the grayling (*Thymallus vulgaris*).

It is true that within recent years grayling have been introduced into the upper waters of the Thames in the interest of anglers, just as in 1816 they were brought by the Houghton Fishing Club to the Test from the Itchen, where they had been established at some previous time. Izaak Walton, writing in the seventeenth century, mentions grayling in the Hampshire Avon, but had they been indigenous there, they would surely have been so in the other rivers of Hampshire also, as the brook trout (*Salmo fario*) undoubtedly is. During the nineteenth century grayling were transported to, and became naturalised in, very many English and Scottish streams in the interest of anglers; but there is no record of any attempt so to distribute the burbot, in which fish anglers take no interest, and in fact it exists only in Great Britain in the rivers between and including the Yorkshire Ouse and the Norfolk Ouse. The question seems to have some significance why these two prolific species should inhabit these rivers and be absent from the Thames.

The following passage in Leonard Mascall's "Fishing with Hooke and Line" (1590) has misled some writers into stating that burbot did inhabit the Thames three or four hundred years ago.

"There is a kind of fish in Holand [south-east Lincolnshire] in the fennes beside Peterborrow, which they call a poult; they be like in making and greatness to the whiting, but of the cullour of the loch [loach]; they come forth of the fennes brookes into the rivers nigh there about, as in the Wandsworth river there are many of them."

It is natural that in writing the "Wandsworth river" Mascall should have been understood to mean the Wandle, which flows into the Thames at Wandsworth. I was deceived in that way myself, until it occurred to me as strange that Mascall should leap suddenly from the Fen district, about which he was treating, to the Surrey side of the Thames. This led me to examine the topography of "the fennes beside Peterborrow," when it became clear that he was referring to the Nen at Wansford, near Peterborough. Probably a London printer familiar with the Wandle thought he was doing the author good service in changing the name.

If, as I think, it may be assumed that neither the burbot nor the grayling ever were natives of the Thames, Sir Andrew Ramsay, had his attention been directed to that fact, might have cited it in support of his theory that the Thames originally flowed westward into the lower Severn valley, which in his opinion was "one of the oldest in the lowlands of England" ("Physical Geology and Geography of Britain"). He considered that the Chalk and Oolite strata through which the Thames flows sloped originally towards the west, and that they received a tilt eastward in consequence of the extensive depression that formed the North Sea.

"When this slope of the Chalk and the overlying Eocene strata was established," he says, "the water that fell on the long inclined plain, east of the escarpment of the Chalk, necessarily flowed eastward, and the Thames, in its beginning, flowed from end to end entirely over Chalk and Eocene strata."

Later geologists have failed to reconcile Ramsay's theory with the formation of the Goring Gap and other clefts in the Chalk escarpment, and I certainly am not competent to call their decision in question. Nevertheless the question still remains (more puzzling to a field-naturalist than to geologists) why burbot and grayling, which are common to English tributaries of the Rhine system, are absent from the Thames and the Medway, and are not native to any westward or southward-flowing rivers in Great Britain

HERBERT MAXWELL.

Monreith.

The Actinium Series and the Lead Ratios in Rocks.

PROF. JOLY in his beautiful work on pleochroic haloes in mica has stressed the importance of a small discrepancy in the observed position of the first halo ring. The discrepancy was shown to vary with the age of the rock It was recognised that the influence of actinium in the formation of these uranium haloes had not been taken into account, but it did not seem possible that the actinium series could have any appreciable effect since it is regarded as only a 3 per cent. off-shoot from the main uranium series. Certainly it could not account for a *shifting* inner ring, and Prof. Joly suggested that the type of thing needed was a variable decay-constant for uranium—such as would arise if uranium had an isotope of considerably shorter life than uranium I. But it can be shown that more than one additional α-ray is needed to account for the observed shifts.

I hope in a more extended article to explain these discrepancies by assuming a different origin for actinium. Dr. A. S. Russell has proposed such a theory by placing AcU_I and AcU_{II} as parent isotopes in the actinium series. He assigned a half-period of 8×10^9 yr. to AcU_I—a period considerably longer than that of U_I. The theory here proposed would indicate a half-period of about $2 \cdot 5 \times 10^8$ yr. (only about $\frac{1}{18}$ that of U_I). The usual connexion between range and decay-constant would assign a range of 3·2 cm. to the α-ray. Such a quick rate of decay leads to some marked contrasts with the assumption of a longer rate of decay. The activity of AcU_I, once as great as that of U_I, is now but a few per cent. On this theory AcU_I would be of no assistance in explaining the departure of the atomic weight of uranium from an integral value, for while the activity of AcU_I is still a few per cent. of that of U_I, the relative mass of it is negligible. An explanation of the atomic weight would have to be sought elsewhere. AcU_{II} also turns out to be necessary, and apparently a range of about

3·4 cm. is prescribed, as will be shown. Equilibrium of AcU_1 and U_1 seems indicated about 10^9 years ago.

These assumptions have a very important bearing on the ages of rocks found from lead or helium ratios. A variable fraction of Ur-Pb would be AcD—the proportion varying from about 40 per cent. in Archaean rocks to 10 per cent. in Devonian. If this is so, a varying atomic weight of Ur-Pb should be found, and in very old rocks a 40 per cent. reduction in ages determined from Ur-Pb ratios would follow. Other interesting consequences and curves showing the shifting of the inner halo ring will be presented later.

An attempt to secure direct experimental evidence of these two α-rays is being made. T. R. WILKINS.

Cavendish Laboratory,
Cambridge, May 5.

Plastic Deformation of Single Metallic Crystals.

IT is a remarkable and characteristic feature of single metallic crystals that when loaded in tension the plastic deformation produced leads to the production of a wedge, the final fracture taking place along the thin edge formed. From the angle of this wedge it is possible to deduce valuable information regarding the actual nature of the mechanism of the plastic flow.

Goucher (*Phil. Mag.*, 48, p. 800, Nov. 1924) has considered the question in relation to his single crystals of tungsten, the relation given being:

$$\phi = 2\tan^{-1}(\tfrac{1}{2}\tan\theta),$$

where ϕ is the included angle between the sides of the wedge and θ is the angle made by the planes on which slipping occurs and the axis of the test-piece.

Although this is given as a general solution, it does not appear to be so, since it is based on the assumption that the point of fracture is distant $D\cot\theta$ from the plane, normal to the axis of the wire, at which the wedge commences to form, D being the diameter of the wire. In the particular case examined by Goucher, however, the formula agreed well with about one-half of the results.

It is possible, however, to treat the problem more generally and, as the result may well become of considerable value, this has been done here. Let ACE and DF (Fig. 1) be successive planes on which slip occurs and p be the perpendicular distance between them. For a uniform wedge the distance through which each plane of atoms moves, *i.e.* AC and DF, will be the same, say q. With ϕ and θ bearing the same meanings as above,

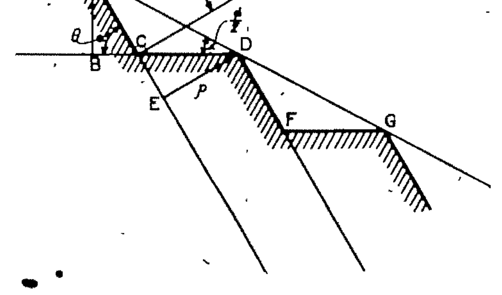

FIG. 1.

$$\cos\frac{\phi}{2} = \frac{q\cos\theta + \dfrac{p}{\sin\theta}}{\sqrt{(q + p\cot\theta)^2 + p^2}}.$$

This relation is now a perfectly general one applicable to any uniform wedge formed by the fracture in tension of a single crystal of any ductile metal. By its use it is possible to extract from the experimental results obtained on these single crystals of tungsten information with regard to the distance through which the atoms move and the number of planes involved which has hitherto remained unrealised.

Of the fractures dealt with in his paper, Goucher points out that they fall into two sharply defined groups with 'sharp' and 'blunt' wedges respectively. About half gave a wedge angle very near to 39°, while the remainder, though giving a mean angle of 54° 12′, varied from about 50° to 60°. For movement on the {112} plane, the one shown to be operative at any rate in the case of the sharp wedges, for the body-centred lattice of tungsten, and for an orientation such that the axis of the wire crystal is perpendicular to the $\{\bar{1}10\}$ plane, θ is $35\tfrac{1}{4}°$ and $p = \frac{\sqrt{2}}{3}d$, where d is the atomic diameter, *i.e.* the distance between the centre of atoms in 'contact.' Putting $q = cd$, the following values of ϕ are obtained:—

c	2/3	1	2	3	10
$\phi/2$ ϕ	15° 50′ 31° 40′	19° 36′ 39° 12′	25° 10′ 50° 20′	28° 15′ 56° 30′	32° 26′ 64° 52′

The significance of Goucher's wedge angle of 39° is now clear. It is almost exactly that which would be produced by slipping on every successive {112} plane through a distance exactly equal to that of the nearest approach of the atomic centres. It is true, of course, that the same wedge angle would result if slipping took place on alternate planes but through a distance of two atomic diameters, but it is certainly less likely that the latter are the conditions than that the movement is through one atomic distance on each plane.

With regard to the more variable blunt wedges, hitherto no very convincing explanation has been offered. Slipping on two symmetrical cube faces would give a wedge with an angle of about 53°, but the wedge itself, if this were the movement, would be at right angles to that actually found. Movement on the {223} plane would also give an angle very near to the mean value for all the tests in this group, but slipping on this plane cannot be regarded as likely. The obvious explanation, however, is seen from the values of ϕ just recorded. Among the values obtained by Goucher there is no angle between 41° and 50°, a fact which is of value in suggesting very strongly that movement takes place on every plane. A movement, for example, through three atomic distances on alternate planes would lead to a wedge angle of 46° 42′, and nothing within 5° of this is mentioned. Now if the explanation of these blunt wedges is to be found, not in a different plane of movement, but in varied degrees of movement on the same—the {112}—plane, and if the movement on every plane is through a multiple of the atomic distance so that the space lattice remains unaltered, the next wedge angle higher than 39° should be 50° and the next higher about 56°. Now 50° is, as we have seen, the minimum angle recorded by Goucher among his blunt wedges and there are six results within 1° of 56°. The largest angle of 60° corresponds with movement through five times the atomic distance.

The results thus suggest that the plastic deformation has taken place by atomic movement on the {112} plane in all cases, on every one of these planes of atoms and by an amount which is in almost every case equal to, or a definite multiple of, the atomic distance, the space lattice thus remaining essentially unaltered and the atoms in their new positions slipping into the depressions left by the removal of other atoms just as would happen if the atoms behaved as hard spheres.

W. E. W. MILLINGTON.
F. C. THOMPSON.

The University, Manchester,
April 22.

On Imperfect Crystallisation in certain Long Chain Compounds.

A SMALL rectangular crystal flake of behenolic acid, $CH_3(CH_2)_7C\;C(CH_2)_{11}COOH$, was mounted on an X-ray spectrometer in such a way that the long edge of the flake was parallel to the spectrometer axis. It was anticipated that this long edge should be parallel to the *b* axis of the crystal, in analogy to the previously investigated stearolic acid.[1] The revolving crystal photograph obtained with this setting was, indeed, almost identical with the corresponding photograph of stearolic acid. It gave, within the limits of experimental error, the same value for the *b* axis. One difference, however, was the extreme faintness of the long spacing. A second exposure obtained with a random setting gave an entirely unexpected picture. Most of the reflected spots on this second photograph were drawn out into arcs of circles. The picture was very similar to certain powder photographs which show orientation effects. It showed that the sample, in spite of its transparency, its smooth surface, and its straight edges, is not a single crystal. The first photograph leads to the conclusion that the small crystal elements from which the flake is built up cannot be orientated completely at random. The only possible orientation of these elements which is compatible with the observations is the following: All the elements have their *b* axes in common. The degree of freedom which is required to explain the powder effect consists in a rotation round the *b* axis (Fig. 1).

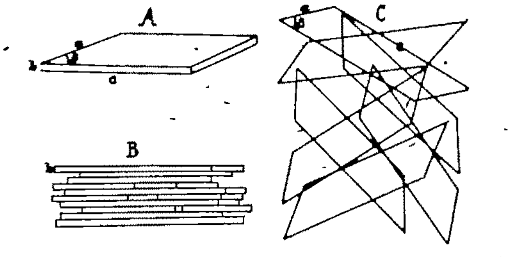

FIG. 1.—A: crystal element, B: arrangement of layers having *b* axis in the plane of the paper; C: another view of the same arrangement having the *a* and *c* axes in the plane of the paper.

An optical investigation of the crystal flake which was made afterwards confirmed the X-ray evidence of an anomalous structure. A true single crystal of either stearolic or behenolic acid shows in convergent polarised light the typical dark bands and coloured fringes. One of the dark bands which lies in the symmetry *b* plane persists in this anomalous crystal. The coloured fringes disappear. It was found later that some of the stearolic acid crystals showed the same phenomena.

An interesting fact is that very similar X-ray photographs to those described here can be obtained from crystals which have been bent. Rocksalt is a well-known example. Another example is maleic acid, the bending of which has been studied in this Laboratory. Supposing a crystal plate is bent in such a way that one of the crystal axes remains undistorted (Fig. 2). The crystal is fixed on an X-ray spectrometer with this axis parallel to the rotation axis. Both rocksalt and maleic acid give under these conditions perfectly normal rotation photographs. For any other setting they show powder effects. The explanation is obvious. The bending produces an internal breaking up of the crystal. The small crystal elements keep the undistorted axis in common—a rotation photograph round this axis shows no signs of this breaking up. The small elements have, after the bending, a random orientation round this axis—a random setting of the crystal gives rise to powder rings on the photographs.

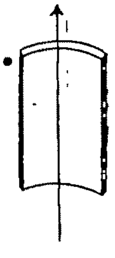

FIG. 2.—Crystal plate of maleic acid bent so that the axis is not distorted.

Behenolic and stearolic acid and most likely many of the long chain compounds grow from the solvent in this abnormal way. The crystallisation seems to go in two steps. The first step consists in an orientation of small crystal elements in parallel layers; the second step is an orientation of these elements parallel to a definite direction in the layer. The fact that these substances can exist in either the degenerate form or in the form of a true crystal illustrates again the instability of their crystals.

ALEX. MÜLLER.

Davy Faraday Research Laboratory,
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The Fundamental Level of the Iron Atom.

IN a paper on the under-water spark spectrum of iron in *Phil. Mag.* (February 1926) and in a letter to NATURE (March 13, 1926, p. 380), Mr. N. K. Sur raises objections against the main result of the writer's classification of the iron spectrum (*Zeit. f. Phys.*, 23, 135, 1924; 26, 1, 1924), namely, the fact that a ^5D term is the lowest term in the energy diagram and that consequently ^5D corresponds to the normal state of the iron atom.

In spite of the fact that this conclusion was confirmed and independently arrived at by Angerer and Joos, as well as by Gieseler and Grotrian's absorption experiments (*Ann. d. Phys.*, 74, 746, 1924, and *Zeit. f. Phys.*, 22, 245, 1924), Mr. Sur maintains that a still lower term (X) must exist—the real normal state of iron—and that the alleged ground level ^5D is going to play only the rather subordinate rôle of a metastable state. Mr. Sur does not state clearly what the character and the quantum numbers of this hypothetical term X should be, although he intimates on p. 447 of his paper in the *Phil. Mag.* and in par. 2 of his letter to NATURE that he means a quintet or septet S term. But even these would be "at variance with the experiments of Stern and Gerlach on the directional quantisation of atoms." Only a $^1S_0$ would be in agreement with Gerlach's results, and obviously singlet terms cannot occur at all among the low terms of iron. (Comp. the last paragraph.)

A comment by Gerlach (*Ann. d. Phys.*, 76, 197, 1925) that some strong absorption lines around

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[1] The samples of stearolic and behenolic acid investigated are monoclinic. Their space group is C_{2h}^4. A more detailed description of their crystal structure will be given shortly. In a note to NATURE, vol. 116, p. 45, July 11, 1925, it was suggested that stearolic acid was triclinic. This statement was made at a time when only very poor photographs were available. Photographs from very much better crystals have been obtained since. It was found that the preliminary conclusion with regard to the stearolic acid was erroneous.

2100 Å.U., which were not included in the writer's classification, probably involve this hypothetical low level, is also quoted by Mr. Sur. Unpublished observations of the under-water spark spectrum of iron made in this laboratory show, indeed, a conspicuous group of absorption lines in the region in question, the strongest being λ 2166·79. But these lines involve the differences of ^5D and form a multiplet with a new high $^5P_{1,2,3}$, which has the relative term values 13862·90; 13686·40; 13589·58 cm.$^{-1}$ (if we put according to general custom $^5D=0$). The reality of this term is confirmed by combinations with the low metastable $^5P'$ and an (unpublished) $^3P'$ term in two groups at 3500 and 4200 Å.U. respectively.

We shall show at first that no other term lower than ^5D can exist, and then that *only* ^5D can be the fundamental lower level of the iron spectrum.

In order to illustrate his point, Mr. Sur compares the iron energy diagram with the neon diagram, emphasising that, although neon possesses a complete spectrum of more or less strong lines in the visible and near ultra-violet, it is entirely unjustified to draw any conclusions as to the *raies ultimes* of neon and its normal state; on the contrary, only the investigation of the Lyman region by Lyman and Saunders as well as by Hertz revealed the true normal state of neon. This conclusion, although correct for neon, does not apply to iron, for two reasons. (1) An upper limit of about 9 volts for the ionisation potential of iron is suggested by the general chemical similarity and by the ionisation potentials of the neighbouring elements, while from the behaviour of the iron lines in the sunspot spectrum we know that it must be larger than 6 volts (according to a letter of Prof. H. N. Russell to the writer). The difference $X-{}^5D$ must therefore be rather small, since we know that ^5D is already 8·15 volts = 66,000 cm.$^{-1}$ distant from the surface of the atom. Consequently, Mr. Sur's alleged ultimate lines arising from X should also lie in the near ultra-violet region, as do the strong lines involving ^5D; (2) the other reason for assuming the difference $X-{}^5D$ to be but small, is the appearance of the first iron lines in absorption at 1250°, and on the other hand the—at least approximate—absoluteness of King's scale in classifying the iron lines. If there were a much lower level than ^5D, King would not have assigned the designation "I" or "IA" to most of the lines which are found to be combinations of ^7P ^7D ^7F, ^5P ^5D ^5F with our ^5D. Their behaviour in the furnace would have been characteristic for Class II. or III., since a difference of about 10,000 cm.$^{-1}$ is equivalent to the interval between adjacent classes.

Assuming the difference $X-{}^5D$, or rather $S-{}^5D$, to be even so large as 14,000 cm.$^{-1}$, the combination with ^7P (1) should give a strong doublet or triplet not farther down than 2600 Å.U. We therefore reject Mr. Sur's point that in order to find this term "the spectrum in the Schumann region must be very thoroughly investigated, and then only can the point be settled." Such an investigation cannot possibly offer anything new concerning the low level of iron.

We are now going to show that *only* a ^5D term can be the lowest term in the iron atom, and for this proof we shall use the recent theory of spectra with several valence electrons, which was brought into final shape by Hund (*Zeit. f. Phys.* 33, 345, 1925). The iron atom with its eight valence electrons has for its low term set the choice between three more or less stable electron configurations, which furnish the following low terms:

Two 4_1, six 3_3 electrons: ^5D ^3H ^3F — — —
one 4_1, seven 3_3 " ^5F ^3F ^5P ^3P — — —
eight 3_3 " ^3F — — —.

The theory thus accounts for all the terms of the low metastable set up to a distance of about 20,000 cm.$^{-1}$. None of these three arrangements furnishes a ^7S or ^5S, and others are of course not possible. It furthermore seems entirely impossible to understand how any S term might arise from the normal state of Fe$^+$ ^6D (according to Russell, *Astr. Jour.*, 61, 223, 1925), since, according to a rule given by Kiess and the writer (*Science*, 63, 234, 1926), the transition from the higher to the lower stage of ionisation always amounts to a removal of the 4_1 electron. How this connexion of the arc and spark terms in iron can be traced is shown in a paper of the writer which is going to appear in *Journ. Opt. Soc. Am.*

The writer cannot agree with Mr. Sur that chromium and iron are comparable to any extent. The fact that in both spectra two prominent ^5D terms occur cannot warrant any conclusions of analogy between atoms of six and of eight valence electrons. The occurrence of S terms, only caused on account of five 3_3 electrons giving as a most prominent term (among others) a ^6S, is rather the exception than the rule in complex spectra. Only Cr$^+$, Mn^{++}, and consequently Cr, Mn$^+$, and Mn have S terms. If Mr. Sur doubts that ^5D is the low term of Fe, does he also question the low D and F terms of Sc, Ti, V, Co, Ni and their analogues in the next period?

O. Laporte.

United States Bureau of Standards,
Washington, D.C., April 6.

Peter Mark Roget and the Voltaic Cell.

The transformation of energy from one form to another was realised in a general way before the middle of the nineteenth century, although it was not until the researches of Joule during the years 1838–1848 and the later work of Kelvin and of Helmholtz that the principle of the conservation of energy became an established doctrine of physical science. It is of interest, therefore, to find the principle of energy applied to the study of the voltaic cell by Peter Mark Roget (1779–1869) so early as 1829. This was before the experiments of Faraday on electrolysis, and nearly ten years before the work of Joule on the energetics of a voltaic cell.

In a work on natural philosophy published under the auspices of the Society for the Diffusion of Useful Knowledge, there is a section on galvanism by Roget. He discusses the chemical and contact theories of the voltaic pile, and brings forward powerful arguments in favour of the chemical theory. He explains that chemical action is always accompanied by a "disturbance of electric equilibrium, in consequence of which a certain quantity of electricity is developed, or, in other words, converted from a latent into an active state." He distinguishes between quantity of electricity and its "degree of intensity or tension," which we now call electro-motive force.

Roget then shows that certain conditions are necessary for galvanic action to take place. Denoting the three essential substances of a galvanic cell by A, Z, C, he explains that between A and Z some chemical affinity must exist and that the same action is not exerted between C and either A or Z. A must be a liquid, C a liquid or solid and Z a solid. If these conditions are satisfied he asserts that a continued stream of electricity will circulate in the direction CZA. If A, Z, C represent acid, zinc and copper, it is evident that Roget's conditions do apply to the ordinary voltaic cell. He goes on to say:

"The absolute quantity of electricity which is thus developed and made to circulate, will depend

> upon a variety of circumstances, such as the extent of the surfaces in chemical action, the facilities afforded to its transmission; . . . but its degree of intensity or *tension*, as it is often termed, will be regulated by other causes, and more especially by the *energy* of the chemical action . . . the energy of the galvanic power will depend altogether upon that of the chemical action, and can never be excited when the latter condition is wanting "[1]

Roget then discusses Volta's contact theory of the pile and says:

> " There are several facts which appear so totally at variance with the immediate consequences of its fundamental hypothesis as to warrant us in rejecting it Chemical action between some of the elements of a galvanic combination is so invariably connected with the production of electrical effect that it would be a violation of all just rules of philosophy not to consider these two classes of phenomena as standing to each other in the relation of cause and effect. . . . If there could exist a power having the property ascribed to it by the hypothesis, namely, that of giving continual impulse to a fluid in one constant direction, it would differ essentially from all other known powers of nature. All the powers and sources of motion with the operation of which we are acquainted, when producing their peculiar effects, are expended in the same proportion as those effects are produced; and hence arises the impossibility of obtaining by their agency a perpetual effect, or in other words a perpetual motion. But the electro-motive force ascribed by Volta to the metals when in contact . . . continues to be exerted with undiminished power in the production of a never-ceasing effect. Against the truth of such a supposition, the probabilities are all but infinite."

Thus Roget makes out a good case for the chemical theory. It was not until many years later, after the work of Arrhenius, Van't Hoff and Nernst, that the rival chemical and contact hypotheses were both included in a wider theory.

Roget is an interesting figure in nineteenth century medical science. He had a varied career and lived to a ripe old age. He was in France when hostilities with England broke out again after the Peace of Amiens and was among the unfortunate *détenus*. After a time he obtained his release, as his father had been a citizen of Geneva. After a period spent in private practice he held various official positions as a medical man. He was the first Fullerian professor of physiology at the Royal Institution and was for a time secretary to the Royal Society and editor of the "Proceedings." Among his publications besides his work on Galvanism we may note the following:—

Animal and Vegetable Physiology considered with reference to Natural Theology. Two vols. Bridgewater Treatises. Treatise 5. 1834, etc.

Third edition with additions, etc. Two vols. 1840.

Vol. 2 of the Library of Useful Knowledge. Natural Philosophy, 1829, etc., contains Treatises by P. M. Roget on Electricity—Magnetism—Electro-Magnetism

An introductory Lecture on Human and Comparative Physiology, etc. 1826.

Tentamen physicum . . . de Chemicæ Affinitatis Legibus, etc. 1798.

Thesaurus of English Words and Phrases, etc. *First edition*. 1852.

D. M. TURNER.

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[1] P. M. Roget, "Natural Philosophy," London, 1829, Galvanism, §§ 70, 72.

An 'Eolith' Factory.

PROF. BOULE'S wash-mills are now rivalling the conjuror's hat—from which all sorts of strange things can be taken by an experienced hand. Years ago they produced what were declared to be typical Harrisonian eoliths; now they have given us "a collection of characteristic types, rostro-carinates, etc." (NATURE, April 24, 1926, p 602), such as are found beneath the Red Crag of Suffolk, while, already, a crushing machine has "produced flakes, some of which . . . might have been taken for scrapers of an Upper Palæolithic or even Neolithic culture." From this it would appear that, with a little less stringent selection on Prof Boule's and Mr Etienne Patte's part, these wash-mills and crushing machines of France will soon be shown to be turning out 'typical' flint implements of all prehistoric periods, and the much-discussed Stone Age thus be made to disappear into the limbo of forgotten things.

Before, however, this dire result is brought about, it may perhaps be as well to consider for a moment or two the evidence upon which this latest wash-mill claim is based. Unfortunately, the illustrations accompanying Mr. Etienne Patte's paper in *L'Anthropologie* (Nos. 1, 2 of vol. 36) are of the indifferent order, but, even so, it appears reasonable to state that the specimens figured bear no real resemblance to those found below the Red Crag, and the claim that this resemblance does indeed exist is, it must seem, due to the fact that Prof. Boule and Mr. Patte have failed to distinguish between the type of flaking exhibited by their wash-mill flints and that of those from the Sub-Red Crag detritus-bed.

Such mistaken comparisons are by no means uncommon in prehistoric archæology, for there are still some observers who, for example, are unable to distinguish thermal flaking on a flint from that produced by human blows. That this conclusion is not unjustified is made clear by a letter which I have received recently from Prof. Henri Breuil, who has examined the actual specimens upon which Mr. Etienne Patte bases his case. It may be said that Prof Breuil does not himself regard the Sub-Crag rostro-carinates with a favourable eye, yet he states that the cause of fracture of these wash-mill specimens is not the same as that exhibited by the Sub-Crag flints, and that the ensemble (of the wash-mill specimens) resembles in nothing the tertiary flints, or even those of the ancient palæolithic period.

History is repeating itself in this matter. In the days when the now accepted palæolithic flint implements were not universally regarded as examples of man's handiwork, a book was published in 1880 entitled "The Antiquity of Man," by Thomas Karr Callard and others, and I would ask those interested in this question to compare the statement published in NATURE (April 24, 1926, p. 602) with the following extracts from this book. On p. 33 we read: "We have said that these Palæolithic implements have a *certain* resemblance to the weapons of the modern savage; but instead of drawing the inference that because man made the latter therefore man made the former, *the resemblance we attribute to a natural cleavage in the flint which gives to it a tendency, however struck or crushed, to break into these particular forms . . .*" (my italics). Putting this thought to experiment, the writer has spent some hours in roughly breaking flints with a sledge-hammer, and the result has been that he has found amongst the broken flint forms sufficiently *resembling* the supposed arrow-heads, spear-heads, serrated edged saws, etc., to convince him that as many years spent in this way as M. Boucher de Perthes and Dr. Rigollot have occupied in their research at Abbeville and St. Acheul, would be likely to result in finding among the broken flints the choice specimens that they have treasured up: "*for it must be borne in mind that they simply made a selection*" (my italics).

Again, on p. 35 we find "Mr. Whitley has shown at the Victoria Institute *specimens of flint broken by Blake's patent stone-breaker, in which a cast-iron jaw is worked by a steam engine, which flints, selected from the broken mass, could not be well distinguished from those which, in the ossiferous caves, are the reputed knives and scrapers of Palæolithic man*" (my italics).

Further comment is unnecessary.

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Frictional Forces in Liquid Surfaces.

WHILE working with a suspended system in which the bottom of the system consisted of a fine wire dipping into a solution of salt in water, it was found that frictional forces existed which resisted rotation of the wire. The suspending fibre was of phosphor-bronze, 0·0015 cm. in diameter and 1 m. long. On this was hung a disc, 4 cm. in diameter, and weighing 10 gm. Fastened to the bottom of the disc was a short piece of No. 30 copper wire dipping a few millimetres below the liquid surface. The liquid was 4 cm. deep.

It was found that often the top of the suspending wire could be turned two or three complete revolutions without any resulting motion of the disc, but when the disc once started to move it would move a considerable distance and with some rapidity.

CARL T. CHASE.

Norman Bridge Laboratory of Physics,
California Institute of Technology,
Pasadena, April 21.

The Disposal of Scientific Journals.

I EXPECT there are many people like myself who are embarrassed by the accumulation of scientific journals, which remain unbound and are so seldom referred to afterwards that they amount to little more than an incubus. I think many of us would be glad of some help towards getting this literature disposed of to the best advantage. I have myself a large accumulation of unbound issues of the *Proceedings of the Royal Society*, the *Journal of the Chemical Society*, *Chemistry and Industry*, etc. After inquiry in likely places I have found no trade market for these. I scarcely like to part with them as waste paper, yet it is difficult to find any better destination.

Perhaps some readers of NATURE may have found a solution of the difficulty, and could give others the advantage of their experience.

S.

Ultra-Violet Photometry.

THE use of optical wedges in photometry is so convenient and accurate that they are now being largely employed, but their use is, at present, mostly confined to the visible region. Dr. Toy (*Phil. Mag.*, 1920) showed that wedges of neutral grey gelatine between quartz plates could be used down to about 3000 Å.U., but the absorption coefficient, and hence the wedge-constant, was increasing so rapidly with decreasing wave-length, that they would probably become useless beyond about 2900 Å.U.

Having recently had facilities for measuring the constants of such wedges on an accurate spectrophotometer, using a sodium-in-quartz photo-electric cell, we found that the constants actually increased but slowly beyond 3000 Å.U. Messrs. Ilford, Ltd., kindly made another new wedge embodying certain suggestions indicated by previous work. The change of wedge-constant with wave-length for this new wedge is considerably smaller than that of a wedge of the standard type, and either type of wedge can easily be used down to 2380 Å.U. at least. (Beyond this there are no lines which we could use in the mercury spectrum, and the mercury arc is the only convenient source of illumination for this work.) The following table shows the change of wedge-constant with wave-length for both of Messrs. Ilford's standard wedges between quartz plates, and also for the special wedge they recently made for us—the wedge-constant for 3655 Å.U. being taken as unity in each case.

The change of wedge-constant with wave-length seems to be a gradual one, and is a very small disadvantage in practice, as it is easily allowed for. The writers have employed Ilford gelatine wedges between quartz plates for photometry of the ultra-violet end of the solar spectrum—*i.e.* to about 2950 Å.U.—for two years with excellent results.

λ.	Wedge-Constant.		λ.	Wedge-Constant.	
	Standard Type.	New Type.		Standard Type	New Type.
Blue	0·7	0·7	2893 Å.U.	1·62	1·30
3655 Å.U.	1·00	1·00	2804	1·65	1·36
3342	1·28	1·10	2752	1·68	1·40
3131	1·50	1·19	2655	1·78	1·45
3022	1·37	1·23	2536	2·00	1·55
2967	1·53	1·26	2480	2·10	1·57
2925	1·60	1·28	2378	2·30	1·63

In the booklet on "Photographic Photometry" recently published, we have stated that neutral gelatine wedges cannot be used for wave-lengths shorter than about 2900 Å.U. as indicated by the earlier results. This now needs correction, since such wedges can be very conveniently used to 2380 Å.U. and probably somewhat further.

G. M. B. DOBSON.
D. N. HARRISON.

Clarendon Laboratory,
Oxford,
May 10.

A Substitute for Microscope Cross-Wires.

IF a microscope or other apparatus fitted with cross-wires is not available, a convenient substitute may be made by placing a coverslip carrying two filaments of seccotine at right-angles between the lenses of an eyepiece.

The coverslip is placed on the end of a cork, which makes a convenient 'bench.' A small quantity of seccotine is squeezed out of a tube; this is touched with a pin or match, and the fine filament produced when the pin is drawn away is manipulated on to the coverslip. The cork is rotated through 90° and the operation repeated. The degree of fineness to which a filament can be drawn depends on the consistency of the seccotine. At ordinary laboratory temperature in winter it was in a suitable condition almost as soon as it had left the tube.

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April 26.

The Next Task of Astronomy.[1]

By Prof. R. A. SAMPSON, F.R.S.

A VERY large amount of work is in progress at present upon astronomical photometry. The older branches of astronomy, astrodynamics and measures of position, are far from being exhausted, and it is a matter for great regret that the former, especially, with its splendid traditions of great workers, of discovery and invention, should have fallen into relative neglect. The middle branch, astrophysics, has so far been based, almost exclusively, upon measures of position, namely, precise determination of spectral lines. Beyond that it has been little more than a descriptive branch—an avenue to science rather than a part of it. But lately from every direction it is being forced to address itself in earnest to the problems of photometry—that is, to face directly and with as much science as it can command, the question of measuring quantity of light-emission.

One is apt to forget that the estimation of stellar magnitudes is coeval with our earliest measures of position. It is found in Ptolemy's "Almagest," accompanied even by a few notes on colour. The six magnitudes into which we divide the naked-eye stars are a legacy from his sexagesimal arithmetic. The subsequent development of the two is in curious contrast. The edifice of positional astronomy is the most extensive and the best understood in all science, while light measurement is only beginning to emerge from a collection of meaningless schedules.

Measures of positional astronomy were originally nearly as meaningless as magnitudes. Successively the position of the observer, the phase of the earth's rotation, precession, the atmosphere, stellar aberration, nutation, the solar motion, stellar parallax, and finally relativity-shifts, required to be discovered, measured and eliminated, before we got down to clean results that referred to the stars and nothing else. To these may be added personality and the theory of instruments, or the allowances that are necessary before measures made by different persons in different circumstances can be combined. All this has been done with a success that is very nearly complete and permits one to remark, first on the extreme complexity and variety of unknown troubles by which simple geometric measures proved to be actually embarrassed, and secondly, on the enormous collateral advantages that accrued to knowledge in general by their solution, including unforeseen conquests of theory, necessity for invention of new methods, new instruments and new outlooks.

Now the place of a star is certainly the datum that matters least about it—except perhaps in statistical grouping. Its mass, its size, its surface temperature, the state of its atmosphere, its radiative emission—if we can get them—are all intrinsically a great deal more significant. All these are absolutely basic data or quæsita of physics. They relate to circumstances of Nature which we cannot imitate in any experiment of our own, owing to the quantities and the temperatures involved, and the isolation. These are Nature's experiments, in her own laboratory, and their variety is for our purposes endless and may be called complete. Our only access to them is by parcels of starlight, and our only treatment for these parcels, after a certain amount of general description, is to measure them, and to cast out from our measures what is irrelevant, personal to ourselves, our situation or our instruments. Difficult and laborious as the prospect may seem, it will falsify all experience if our labours do not yield us unexpected stores of gain, new and unforeseen relations, besides what we set out to master.

I would repeat that the measurement of radiation is a physical question of absolutely basic importance. Every step matters on the road to its elucidation. This is the question I refer to as "The Next Task of Astronomy," because a large part of it, and necessarily a critical part of it, falls in the astronomer's field. In spite of all the work that has been done upon it up to now, it is still, in the main, in a crude stage, much behind where we might, with proper effort, place it, and out of all comparison behind the position of measures of place. Therefore it offers a field which both astronomer and physicist can be sure they will not cultivate in vain.

Very few years ago there was but a single star for which a photometry that was physically significant was attempted. This was the sun. Here all the necessary allowances that were known were made, the first being a very elaborate and difficult determination of the effect of the earth's atmosphere, and the elimination of it. Then there was the measure of the sun's own radiation. This might be done in bulk, or separately for each wave-length. In either case the true measure is taken as a heat measure, an energy measure. As to that, there is more to say than used to appear. Questions of fundamental interest suggest themselves, and will certainly call for investigation hereafter. For the sun, the standard detecting instrument at present is the bolometer, which in principle is a Wheatstone's bridge, balanced upon a pair of exceedingly fine short strips of platinum, one of which receives the selected radiation and responds to it by an increase of resistance. Increase of telescopic power has made it possible to extend this method to certain stars, employing as detector either Nichol's radiometer or Coblentz's vacuum thermocouple. C. G. Abbot, with the 100-inch telescope at Mount Wilson, has been able to record the actual distribution of heat-radiation of nine stars, over the whole visible spectrum and far into the infra-red. Coblentz has obtained results nearly equal to these. Deflexions corresponding to integrated radiation for the whole spectrum are readily obtained by the same means for far fainter stars.

Interesting though this is, personally I regard it as a *tour de force*; like the interferometer measures of stellar diameters, it does not hold out any promise of general use, and gives measures which serve only to confirm results that are more conveniently and as certainly obtained otherwise.

Besides the interest attaching to a new feat, however, such measures are true physical photometry, as absolute as we can make them. The same cannot be said of our chief standard, the north polar sequence. Perhaps nothing speaks more clearly of the detached, inconclusive and essentially unscientific position of stellar photometry than the labour spent upon establishing and verifying this work, without reference to its subsequent physical interpretation. If my words are depreciatory, this does not mean that I undervalue those who worked at it, or what they have given us; it is to remind workers of to-day that we have got into a different era, in which astronomy has definitely and finally joined hands with physics, each serving and responsible to the other, for mutual profit.

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[1] From a paper read before the Optical Convention, 1926, on April 13

The north polar sequence was devised by E. C. Pickering at Harvard, as his ultimate standard of photometric reference. It consists of a carefully graded series of stars within 4° of the north pole.

The accepted scale for magnitude is Pogson's, which he derived from J. Herschel, defining increment of magnitude as proportional to increment of log (intensity), so that an increment of magnitude, dm, varies as $-dI/I$, where I is the intensity. This is in accordance with Fechner's law, by which a physical intensity is translated into a sense-measure; its significance is the escape from introducing an arbitrary external unit to measure dI—the instantaneous value I serving for that purpose. To establish a standard sequence in accordance with this definition, Pickering deliberately employed a variety of instruments and methods, relying upon their mean to cancel the comparatively large discrepancies. Such a plan may have been the best to use at the time it was devised, but it is obvious that it may leave a residue of systematic error. It was ascertained to do so by F. H. Seares of Mount Wilson, and this was confirmed by H. Spencer Jones at Greenwich. But these are no more than the incidents in fixing a critical standard, and one can scarcely suppose equal results could have been better or more readily obtained.

What I criticise in the investigation of 'magnitudes,' of which the standard sequence is merely the best, and one of the least extensive, examples, is that the measure is a measure of a mixed phenomenon, which has never been analysed to its physical basis, and which it is usually impossible to complete afterwards. There are always and obviously three elements that contribute to the measure—the actual radiative emission of the source, losses in transit by dispersion, absorption and reflection in the instrument and the atmosphere, and finally the peculiar sensitivity characteristic of the receiving apparatus. One form of the latter is the eye, supposed reduced to a standard, and equivalent to a photovisually corrected lens used in conjunction with an isochromatic photographic plate and a rather ill-defined yellow filter. The result can be made sensibly the same and sensibly uniform.

The position is decidedly more unsatisfactory when we deal in photographic magnitudes. Apart from such investigations as I advocate below, which have not yet received a recognised place in astronomy, the basis of the adopted treatment is frankly empiric, and empiric in a way that holds out no promise of a better foundation. After numerous experiments a formula has been settled on, $m = a + b\sqrt{d}$, where d is the measured diameter of the photographed image, and a, b turn out to be sensibly constant over considerable ranges. It is a very convenient rule, and it has turned out a great deal of very useful work, but in a physical sense it is hopeless.

Now if we accept the heat radiation as standard, it is of course familiar that the estimate of intensity made by the eye, whether analysed or summed, is distorted. Abbot, for example, extended his bolometric measures beyond wave-length 2μ, to which the eye is perfectly blind. We require an equation of conversion and a different equation according to the partition of emissive energy along the spectrum. We can imagine then a reduced 'bolometric' magnitude, as introduced by Eddington, which corresponds to the true heat emission of the star, the correction that produces it being a function of the spectral class of the star. This correction is large, exceeding a magnitude at both ends of the scale. Equally a photographic magnitude, derived from an ordinary photographic plate, would require a different, similar correction, but it is more usual first to reduce the photographic magnitude to the photovisual, by estimating the difference between the two known as the 'colour correction,' and itself an index of the spectral class.

Thus, apart from instrumental and atmospheric difficulties, photometry is helpless without at least two measures, to give, between them, the total heat emission and the spectral class, or in other words the size and the shape of the Planck radiation curve. This statement assumes that the star radiates as a black body, which is sufficiently though not closely or invariably verified. So many ways are known for finding spectral class that it is sufficient merely to mention them. They are designed to apply to different cases, according as we want detail or collective summary, and can dispose of much light or little. The slit spectroscope, the prismatic camera, effective wave-lengths determined by the position of the secondary images formed by a very coarse grating, photographs with different colour screens interposed, and even eye estimates of colour.

To speak first of one of the desiderata, it has been verified beyond any doubt that the temperature indicated by the shape of the Planck emission curve of the star, which is taken as the 'effective temperature,' or the surface temperature of the star, implies quite strictly the spectral class, with its intricate detail of absorption lines. It remains only to confirm the fact by defining the relation more closely and better cleared from impurities, to examine how nearly the black body radiation actually applies to a star, and finally to search out exceptional cases.

As this branch of the research has been carried out with fair success and with general agreement in result for different methods of treatment, some detailed reference may be made to the questions it has evoked. The investigation proceeds from the evident fact that the balance of intensity of a star's radiation shifts from the blue to the red as we cross the spectral series. Presumably this is a temperature effect which may be interpreted by means of Planck's radiation curves. If we assume that the star's radiation is itself black-body radiation, it would suffice to use Wien's law and determine the summit or maximum of the curve, but it is preferable to make no assumption and attempt to determine the whole curve. In any case we require to calibrate our apparatus of reception by seeing what it records when exposed to a standard source. It is possible to make such a source terrestrial. Wilsing employed as his standard an electric oven, constructed as a black body, against which he calibrated a glow lamp, which in turn was compared with the stellar spectrum. His work was visual. The method requires the subsequent elimination of instrumental and atmospheric losses. The latter vary rapidly and greatly. Accordingly Wilsing's measures show a rather wide dispersion, and there are some improbable results for individual stars. Besides, the general scale seems low, so that systematic error has not been avoided. But these are minor criticisms by which one tries to learn the lesson of the difficulties. The whole work, including that of his collaborators Scheiner and Münch, is a monument of skill and care.

To vary the method as Wilsing's experience suggests, I have photographed the spectra upon panchromatic plates sensitive up to Frauenhofer's (B), and in place of the terrestrial source as standard I have made comparison with a similar spectrum of Polaris, taken first and last on each plate, to guard so far as possible against atmospheric vagaries. Apart from altitude effect, it is assumed that both stars are equally affected by losses, so that there is no allowance to be made in the relative measures. We have then before us an interesting problem of interpreting the photographic deposit in terms of the active light. Different times of exposure and different wave-lengths enter with the changing sensitivity of the plate. It is in fact the basic problem of sensitometry. One might say that little can be said of it, except that it is enormously complicated. What the star contributes is merely a 'latent image' that cannot be examined, and the outcome depends on the chemicals used, their handling and temperature. The material employed is none too uniform. It is altogether a region that has hitherto been avoided, and that one would rather avoid if the gain were not so manifest of reducing it, even partially, to order. Besides, what is the alternative? There are exactly the same obscurities in using the eye, but it gives no permanent record that one can experiment on and cross-examine. Two other detectors of the same order of sensibility are offered—the selenium detector and the photo-electric cell. Whether photography may be more or less obscure than these, in a metric sense, it is certain we are more familiar with its troubles, and are in any case bound to use it for other purposes. Hence it appears to me, the sooner the discussion of the photographic deposit is reduced to a standard for scientific purposes, the better.

My own effort has been confined to reducing the complexity by defining the circumstances. If the temperature, chemicals and handling are kept the same, and if the photographic constants p and γ are separately determined in the laboratory for each batch of plates and for each wave-length used, then it would appear that the blackening of the plate can only depend on the intensity of the light and the time of exposure, or alternatively, the intensity is a function of the blackening and the time. The last two are measurable, so that to derive the former requires merely the establishment of a calibration curve in the laboratory as indicated above. Departures must be treated as accidental anomalies. It can be shown that a manageable theory may be built on this basis, applying at any rate to the case when the desideratum is the shape of the radiation curve, leading to an easy equation between the relative temperatures of two sources, as indicated from any wave-lengths at which their spectra are compared.

It will be noted that this method fails to provide an absolute standard temperature unit, as basis. This, however, may be supplied by taking the temperature of a 'Go' star the same as that of the sun; but in fact when a great many stars are used, the indeterminateness is distributed over them all, and it is found that a coherent treatment permits of very little latitude, without thrusting very improbable figures upon one or other of the extremities.

A parallel treatment of the area of the radiation curve, giving the total bolometric emission of the star, should not present any insuperable difficulty. We should then have by direct determination the two fundamental elements of the star's radiation, temperature and quantity.

. . . .

The measurement of the intensity of individual lines in the spectrum promises at least as much interest as a treatment of the whole. But in writing this summary directed to a special object, I have omitted many points which mean a great deal to those conversant with astronomical literature. If we want to pass from the 'magnitude' of a star to its radiative emission, we require to know the magnitude of the sun and the distance of the star. A few decades ago the number of stellar distances known was so insignificant that no general treatment was possible. It was the want of this knowledge that really accounts for some of the deficiencies of which I have spoken above. But that is now past. Some thousands are now determined, and their number is still rapidly increasing. Of stellar masses we still have only a very few determined directly; but a well-credited theory permits us to calculate these too, even for individual stars. These are necessary adjuncts if astronomy is to unite itself with physics, and the astronomer may be relied upon not to fail in supplying them.

The Active Principles of the Pituitary Gland.

SINCE the discovery by Oliver and Schafer of the blood-pressure raising or pressor effect of extracts of the posterior lobe of the pituitary gland, a number of other phenomena caused by injections of this material have been described; thus although in mammals the blood-pressure is raised, in birds it is reduced; in the former the extract also stimulates the uterus to contract, and produces an increased flow of milk and an increased secretion of urine, under certain conditions, but under others the urinary flow is markedly diminished. In frogs the extract stimulates the pigment-carrying cells or melanophores to dilate, producing thereby a darkening of the skin of the animal. It may be noted that these active principles are all obtained from the non-glandular posterior lobe of the organ, which is composed chiefly of neuroglial tissue, although it has a partial investment of glandular cells from the *pars intermedia.* The glandular anterior lobe, which is essential for normal growth, has not yet yielded for certainty an active extract to the labours of the biochemist.

Are these various active principles, designated in the present state of our knowledge by an adjective descriptive of the effect produced, all different, or is there only one, or possibly only two or three? Subject to the isolation of one (or more) in a chemically pure condition, we can only attempt to reach an answer to this question by consideration of the indirect evidence which is available. Before reviewing some recent work on this subject, attention may be directed to one or two points. It is generally held at the present time that the diuresis observed after injection of a posterior lobe extract intravenously into an anæsthetised animal is caused by the rise of blood-pressure simultaneously produced, with perhaps a dilatation of the kidney blood-vessels, and that the galactogogue effect is due to the same principle stimulating the smooth muscle fibres in the walls of the ducts of the mammary gland, and so leading to an expression of the milk already secreted; in neither case is it considered that the extract stimulates the kidney or mammary gland cells to increased activity. It appears almost certain that some of the effects must be pharmacological rather than physiological; the usefulness of a principle which will produce a flow of milk and an expulsion of a fœtus from the uterus to a fish or frog is obscure.

Evidence as to the identity or otherwise of the active principles has been sought by an examination of the glands of different species for the presence of the various activities associated with gland extracts. According to a table given by L. T. Hogben and G. R. de Beer (*Quart. Journ. Exper. Physiol.*, 1925, vol. 15, p. 163), extracts of the pituitaries of elasmobranch and teleost fish, amphibia, reptiles, birds and mammals produce all the effects obtainable from such extracts, except that there is some doubt as to the presence of a pressor and diuretic principle in the gland of the skate. The authors have made quantitative comparisons of the contents of the skate's and cod's glands in the pressor and oxytocic (uterine-stimulating) principles, and have found that the latter contains twenty to thirty times as much oxytocic activity as the former, tested on the virgin guinea-pig's uterus, whilst the pressor activity of the cod's gland is at least five times more than the skate's, tested on the spinal cat. Unfortunately, the doses of skate's gland extract used failed to produce any rise of blood-pressure; it is possible that with larger doses some rise might have been obtained, seeing the great difference in their relative oxytocic activities. Hence the experiments are inconclusive, but afford no evidence that the two principles are separate chemical compounds.

Since the principles are so widely distributed throughout the animal kingdom, the differentiation between them must be made, if at all, by other means. Is there any difference in their distribution in the gland of a single species? That is, can differences be detected between their concentrations in the *pars nervosa* and in the *pars intermedia*, both of which structures are included in the posterior lobe? Hogben and de Beer have also investigated this question and find that in the pituitary gland of the ox the *pars intermedia*, although containing roughly only one-fifth of the amount of the principles in the *pars nervosa*, yet consistently contains more of the oxytocic principle than of the pressor, although usually the difference is not great. The authors favour the view that these two principles are probably different chemical substances.

Further light is shed on the problem by greater knowledge of the chemical properties of the active substances, and of their specific or non-specific nature. Thus Hogben (*ibid.* p. 155), investigating the depressor effect of injections of extracts of the posterior lobe in birds, finds that other tissue extracts fail to give this response; moreover, the chemical properties of the active principle are, so far as investigated, the same as those of the other principles and different from those of a non-specific depressor such as histamine. The compound is localised mainly in the *pars nervosa.*

The principle influencing the secretion of the urine has been investigated in some detail by N. S. Craig (*ibid.* p. 119). The *diuretic* action of posterior lobe extracts was the first to be discovered, and it was only later found that in the disease *diabetes insipidus*, characterised by great thirst and the passage of large volumes of urine, subcutaneous injections abolished temporarily both the thirst and the polyuria, thus exerting an *antidiuretic effect*. It appears, therefore, that one of the functions of the posterior lobe of the gland is to maintain the concentration of the urine; if this function is deficient, polyuria and thirst result. Craig finds that, injected subcutaneously into unanæsthetised cats, the extract delays the diuresis produced by giving water or saline solution by mouth, but has much less effect on that following the exhibition of a solution of urea. No evidence of a delayed absorption of the fluid from the gastro-intestinal tract was obtained, so that it must be retained in the body after absorption; certain observations on the hæmoglobin percentage in human blood after the administration of fluid by mouth and the injection of pituitary extract confirm this result. The author inclines to the view that the principle exerts its influence by an action on the cells of the kidney.

It is usually stated that extracts of the posterior lobe stimulate all forms of smooth muscle. A. D. Macdonald (*ibid.* p. 191), as the result of an investigation of their action upon isolated strips of smooth muscle from the mammalian ileum, disagrees with this statement. He finds that not all commercial extracts stimulate this preparation, that the stimulating substance can be preferentially extracted from laboratory-desiccated posterior lobe by alcohol, which extracts the non-specific depressor compound, and also to a certain extent by ether, which extracts neither the pressor nor the oxytocic principles, that it is present in other tissues, and hence is not a specific principle of the pituitary gland, and that it is not destroyed by boiling in dilute alkali, which treatment deleteriously affects both the pressor and oxytocic activities. It is probable, therefore, that the stimulating substance is histamine, which occurs in most tissue extracts, and that it is not quite completely removed from desiccated posterior lobe preparations by alcoholic extraction; although a preparation thus treated may show no depressor effect on injecting a second dose into a mammal, yet sufficient histamine may have been left behind to stimulate the smooth muscle of the intestine, since the latter is about one hundred times more sensitive to histamine than it is to pituitary extract. It is possible, from some experiments on the heart of the dogfish, that small quantities of choline are also present in most posterior lobe extracts. Hence it must be concluded that any gut-stimulant action which pituitary extracts possess is very largely or entirely due to the presence therein of the non-specific stimulants histamine and choline.

Finally, reference must be made to the attempted chemical separation of the active principles. As W. Schlapp (*ibid.* p. 327) points out, the identical behaviour of the different principles through a large number of chemical manipulations is not sufficient evidence of their chemical identity, more especially as the non-specific histamine apparently accompanies them in many cases. On the other hand, a separation of two by a single chemical treatment would argue very strongly in favour of their non-identity. The author finds that the pressor, oxytocic and melanophore principles are all destroyed at the same rate by boiling in dilute acid, but that the pressor and melanophore activities are not extracted by butyl alcohol, whereas the oxytocic largely passes into this solvent; furthermore, lead sulphide adsorbs almost all the pressor and melanophore material present in a solution, but only about half of the oxytocic. He concludes that the pressor (and melanophore) and oxytocic activities are mediated by two separate and distinct substances, thus agreeing with Hogben and de Beer, who by a different method reached a similar conclusion. Now the melanophore principle appears to exist in greater concentration in the *pars intermedia* than in the *pars nervosa*, thus resembling the oxytocic but differing from the pressor principle. Hence it appears probable that these three activities of posterior lobe extracts are due to the presence in them of three different chemical compounds. Their relationship to the avine depressor and antidiuretic principles requires further research for its elucidation; whilst Macdonald's results throw doubt on the specificity of the galactogogue effect. The conclusions reached from a consideration of the work mentioned above agree in general with those which may be drawn from the experiments of other investigators.

Vital Statistics of Scientific Academies.[1]

A COMPARISON of the life statistics of such bodies as the Royal Society of London and the scientific academies in other countries is interesting, because the efficiency and influence of these institutions depend to some extent on the average age of their membership. Unless they contain a sufficient sprinkling of the younger generation and elections are not delayed until a man has done his best work, the institution will cease to command confidence and be hampered in the fulfilment of the object for which it was founded. We welcome the publication of the statistics collected by Prof. Raymond Pearl, and published by the National Academy of Sciences of Washington, because it allows us—so far as the limited material permits—to form a judgment of the effects of the conditions of election, which differ materially from those applying to the Royal Society. The latter, as is well known, has elected since 1848 fifteen members every year, while the leading scientific body in the United States has followed the practice of Continental academies and limited its total membership.

A statistical inquiry was first made in England by General Strachey (*Proc. Roy. Soc.*, vol. 51, 1892) in the latter part of the last century, primarily for the purpose of forecasting the ultimate membership of the Royal Society, which had fallen from 768 in 1848 to 427 in 1891 (not including 36 fellows elected under a special rule). There were then still 26 members alive who were fellows in 1848, when the statutes were changed.

In the United States the problem is reversed, the question being, what the number of elections per year should be so that the Academy might settle down at the maximum membership fixed by charter in 1863 at 250.

The National Academy started with a membership of 48, and, anxious no doubt to set a high standard, it was slow in making any substantial additions. During the first twenty years of its existence ninety-five new members—that is, less than five per year—were elected, and the number of elections diminished still further in the second period of twenty years, when the annual average of new members fell to a fraction more than three. Since 1905 the Academy increased more rapidly "under pressure of an arbitrary rule which virtually forced the election of 15 per annum." Reference to this rule occurs twice on the same page in Prof. Pearl's publication, but its exact terms are not stated.

The average age of members of the National Academy on May 1, 1925, was practically identical with that which I found for fellows of the Royal Society at the beginning of 1923, being 60·7 years in one case and 60·9 years in the other. But there is a great contrast in the admission of men below middle age. During the sixty years that have elapsed since the first nominations under the charter, Washington has elected only one man below the age of thirty, while the Royal Society has elected twenty-nine in the course of seventy-five years. The same tendency is shown in elections below the age of forty years. The percentage of elections under that age was 33·9 at the Royal Society and only 19·9 at Washington. The further fact emerges that the election of younger men to the National Academy has very markedly and steadily decreased since its foundation. On this point Prof. Pearl makes the following startling remarks:—

> "It is easy to attribute the changing habits of the Academy relative to the election of young men to a growing conservatism of that body itself. That this is the sole cause I doubt. It is at least possible, and I incline personally to think it probable, that the increasing organization, standardization, mechanization, and constant striving for efficient mediocrity in all our academic life, which every thoughtful person has seen going on during the past 30 years, and which some have deplored and vainly endeavoured to stop, is showing as one of its most dreadful effects the curbing and fettering of the progress of the really brilliant student."

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[1] Vital Statistics of the National Academy of Sciences: By Raymond Pearl. *Proceedings of the National Academy of Sciences* (vol. 11, No. 12, 1925).

It is not for us to comment on this formidable indictment.

At the Royal Society the decline in the number of elections of young men appears to a much smaller extent, and may be accounted for without assuming a decline in intellectual power. The statistician had better confine himself to his job; and if he ventures on explanations it is safest to assume that the general intelligence of a country is less likely to change than the state of science, which at different stages of its progress requires different types of intellectual activity.

One factor affecting the average age of admission is the greater competition due to the enormous increase in the scientific output of the British universities. This is strikingly illustrated by the increase in the number of men presenting themselves for election. The assistant secretary of the Royal Society has kindly supplied me with the relevant figures. I have collected these in the following table, in which the columns headed '*N*' give the five-year averages of the numbers of candidates.

Period	*N*	Period.	*N*	Period.	*N*
1848–1852	30	1873–1877	53	1898–1902	86
1853–1857	36	1878–1882	53	1903–1907	84
1858–1862	42	1883–1887	60	1908–1912	96
1863–1867	50	1888–1892	68	1913–1917	116
1868–1872	52	1893–1897	73	1918–1922	113

I have not ascertained the ages of the candidates, but am under the impression that they would show a slight increase in the last twenty years. Since 1922 the number has been 112 on the average.

ARTHUR SCHUSTER.

Obituary.

MR. JOSEPH LUCAS.

MR. JOSEPH LUCAS, who died on April 20 last at the age of seventy-nine years, was educated at Westminster School and in 1867 joined the Geological Survey of Great Britain. During his nine years in the service he was employed in mapping the Carboniferous rocks in the West Riding of Yorkshire, and, later, the area in north-east Yorkshire, within which the Cleveland ironstone occurs. While in the West Riding he was much impressed with the great amount of water yielded by the Lower Carboniferous sandstones, and this probably led to his taking up the study of water supply and the profession of water engineer on his retirement from the Geological Survey.

Although his investigations covered many parts of England, Mr. Lucas concentrated on the area of the Thames Valley, and all his more important publications dealt with this region. His work was marked by a distinct originality of thought and at once brought him into public notice. He was probably the first to publish a hydrogeological map with artesian contours, which he defines as a series of lines drawn through a number of points at which the water rises to the same height above Ordnance Datum. He gave much additional evidence of the steady fall of the underground water-level in the Chalk and suggested that such maps should be prepared at intervals, as by them this fall in the water-level would be more clearly shown.

A fairly full summary of Mr. Lucas's more important publications and conclusions are given by Whitaker in his comparatively recent work on the water supply of Surrey (*Mem. Geol. Survey of England and Wales*, "The Water Supply of Surrey," by W. Whitaker (1912), pp. 14-17. See also Bibliography (*ibid.*), pp. 328-330). A brief account is here given of Mr. Lucas's first paper, "Horizontal Wells" (published privately in 1874), and of his second and better-known "Artesian System of the Thames Valley," published in 1877 in the *Journal of the Society of Arts*, vol. 25, No. 1277, p. 597. The second work contained the original and valuable "Hydrogeological Map" showing the underground contours of the water-level in the Chalk, but referred only to the area south of the Thames. In 1878 he published privately a complete map of these underground water contours both north and south of the Thames. This proved so instructive that it was republished by the Geological Survey together with two other similar maps showing their position first in the period between 1890 and 1900 and later in 1911 (*Mem. Geol. Survey of England and Wales*, "Records of London Wells," by G. Barrow and L. J. Wills (1913), p. 19).

Later on, Mr. Lucas turned his attention to the water supply that could be obtained from the Lower Greensands of Hampshire and Surrey, and a short résumé of the work was published in 1880. Though he continued to practise as a water engineer for some years, he ceased, after this, to make any further publications of general scientific interest.

DR. B. P. GRENFELL.

THE death is announced of Dr. Bernard Pyle Grenfell, honorary professor of papyrology in the University of Oxford, which took place at Eley, Perth, on May 17. Dr. Grenfell was born in Birmingham in 1869, and was educated at Clifton College and Queen's College, Oxford. After taking his degree with first-class honours in both Moderations and *Lit. Hum.*, he was elected to the Craven fellowship and a fellowship at his own College.

In 1894 Grenfell began work as an excavator under Sir Flinders Petrie, who confided to him the editing of a Greek roll which proved to contain enactments of Ptolemy Philadelphus I. of the greatest importance for the currency and fiscal systems of Egypt. It was in this year that there began his long association with A. S. Hunt, which was to prove so fruitful in the study of the fragments of papyri which they discovered in the course of their excavations at Oxyrhynchus. From these were derived the "Sayings of Jesus" and the many other fragments published in the Oxyrhynchus series, which have thrown a flood of light on many aspects of the social and religious life of Egypt, as well as much matter of literary interest and of importance to the scholar. Grenfell himself was especially interested in the intricate problems of finance and currency in Egypt—a subject in which he had early shown his competence in a masterly account of the ratio of silver to copper which had appeared as an appendix to his edition of the Ptolemy text referred to above.

In 1906, while excavating at Oxyrhynchus, Grenfell broke down through overwork. Though he recovered for a time, he broke down again in 1908, the year he was elected first professor of papyrology at Oxford, and it was only intermittently that he was able to resume work after that date. In 1913 he was appointed honorary professor of papyrology. He was an Hon. Litt D. of the University of Dublin, and Hon.D.Jur. of Graz, corresponding fellow of the Munich Academy, member of the Academia dei Lincei, and Drexel medallist of the University of Pennsylvania.

THE death of the eminent French entomologist the Abbé J. J. Kieffer occurred on December 30 last. For many years he was on the teaching staff of the College of St. Augustin at Bitche in Lorraine, where he devoted himself largely to entomological research. His earlier work was concerned with the taxonomic study of gall-making Diptera and Hymenoptera, but latterly he turned his attention to the Chironomidæ and became the foremost European authority on the family. His most enduring contribution is his "Monographie des Cecidomyides d'Europe et d'Algérie" (1900), which contains a wealth of biological and anatomical information, and is profusely illustrated. His death leaves a gap in the ranks of the few students of the difficult and obscure groups of insects among which he laboured so assiduously.

WE regret to announce the following deaths:

SIR Harry Brookes Allen, emeritus professor of pathology in the University of Melbourne, and president in 1908 of the Australasian Medical Congress, aged seventy-one years.

Dr. J. T. Bottomley, F.R S., for many years Arnott and Thomson demonstrator (experimental physics) in the University of Glasgow, and the author of elementary text-books on dynamics and hydrostatics and of papers on the thermal conductivity of water, permanent temperature of conductors, etc., on May 18, aged eighty-one years

Prof. L. A. Herdt, professor of electrical engineering at McGill University, Montreal, and president of the Canadian National Committee of the International Electro-technical Commission, aged fifty-three years.

News and Views.

IT is gratifying to note that a serious effort is being made in the United States to assist the development of research in pure science, and in that land of dollars, concentrated energy, and munificent benefactors we have little doubt that the scheme adopted by the National Academy of Sciences will meet with the success it deserves. The general purpose of this scheme is "to increase and strengthen American contributions to the mathematical, physical, and biological sciences by the creation of a national fund to aid skilled investigators." Universities and other higher institutions will be expected to co-operate by assuring complete sympathy with research, by relieving the professoriate from the excessive demands of teaching and administration, and by providing all necessary laboratory accommodation and facilities. The endowment fund which has now been launched, and by means of which it is hoped to raise twenty-five million dollars, will be controlled and administered by a board of trustees consisting of Mr. Herbert Hoover, as chairman, and twenty-five well-known public men, including some of the foremost scientific workers. In a brochure recently issued by the National Academy of Sciences, the trustees declare their conviction that the funds at present available for the support of research in pure science are far below what the population, education, and material resources of the country demand. The United States already occupies a leading position in industrial research, it should rank with the most enlightened nations in the advancement of pure science.

RUSSIA affords a field for research in so many important branches of knowledge that any indication of a revival of interest in scientific matters among her people is of more than local moment. Under the Empire the study of the archæology, ethnology, and cultural history of the vast territory included within its boundaries was actively pursued, but unfortunately the results were not made widely known. Publication was much delayed, and comparatively little appeared in languages other than Russian It is possible that under the Soviet Government conditions may be changed. It would appear at any rate that there is a strong desire to encourage the continuation of the scientific work which was carried on under the old regime and even to extend it. As an example, we may mention the development of the regional survey. The extent to which this form of activity has been encouraged and the proportions it has now assumed are described in a paper by Prof. P. D. Schmidt, of Leningrad, which was read at a meeting held in London in September last to celebrate the tercentenary of the Russian Academy of Sciences, and is now published in the *Sociological Review* for April. The movement began in 1921, when a Congress was held on the initiative of the Academy. A central bureau was organised in January 1922 at Leningrad with a branch at Moscow. By March 1923 there were 231 societies with 285 museums, 21 biological stations, and 16 natural reserves or parks, and in June 1925 it was estimated that there were more than a thousand institutions dealing with regional surveys. The museums have proved the most successful feature and are very popular among the peasantry; but a great deal of original work has been done in biology, geography, archæology, and the study of local history and culture, and most centres publish a periodical dealing with these activities.

MACHINE design has made during the last century enormous developments and shows no signs of having reached a standstill, but the designer as a rule considers primarily the work to be turned out by the machine and gives relatively little attention to the operator of the machine. Nor do operators, as a rule, complain when the construction of the machine induces bad posture, inconvenience, or fatigue, for with habit they become acquiescent to an existent state of affairs. The Industrial Fatigue Research Board in a recent report (H.M.S.O., price 1*s.* 3*d.*, No. 36) by Legros and Weston directs attention to this neglect. Investigations have been made into machines used in laundries, leather factories, sheet-metal trades, textile trades, etc., from the point of view of the worker, and it is found that much fatigue and faulty posture might be eliminated by altering the designs somewhat. Suggestions are made for improvements. The Board points out that the work is in a preliminary stage and deals only with a few examples of industrial machines. It is, however, a very important aspect and the report is timely in its insistence that the unit is not the machine but the worker and the machine.

A REPORT on the administration of the Meteorological Department of the Government of India in 1924-25, and a general survey of half a century's work since the establishment of the department, has recently been issued by Mr. J. H. Field, Director-General of Observatories. This is the fiftieth administration report of the India Meteorological Department, and records the completion of the first half-century of systematic observations on weather in India by uniform methods. The retirement of Sir Gilbert Walker, who for some twenty-one years ably directed the policy and work of the department, is an especial feature. During the year the services of cyclone warning to ports and shipping, and of flood warnings to officers in the irrigation, railway, and other departments, were carried out. The period was marked by heavy localised rainfall, causing destructive floods from time to time in various parts of India, but the sea areas were unusually free from severe storms. Upper air work has been carried out in association with Army Headquarters for the needs of artillery and Royal Air Force, and telegraphic forecasts of bad weather were sent throughout the year to these authorities. The probability of closer co-operation with the Royal Air Force as the development of civil and military aviation progresses, is alluded to. Marine meteorology is being actively advanced, and wireless weather messages from ships at sea are used to supplement the coast observations in cyclone-warning work. Rainfall registration is carried out at nearly 3000 stations scattered well over India. The historical survey of half a century's work is of considerable interest.

A PUBLIC lecture on "The Ethnographic Approach to the Native Problem" was delivered by Capt. G. Pitt-Rivers at the London School of Economics, Houghton Street, Aldwych, on Tuesday, May 18. The subject is one on which Capt. Pitt-Rivers is especially competent to speak. His experience of native administration in the Papuan area has given him a clear insight into the difficulties of the native problem, to which he has also devoted close study from the special point of view of the anthropologist. Current events in the Union Parliament of South Africa serve as a reminder that the native problem is an insistent one in any widespread association of peoples such as the British Empire. Those who are most competent to judge and are most closely acquainted with the conditions in British tropical and sub-tropical dominions and dependencies are convinced that the ultimate prosperity of the State and the well-being of the individual are largely dependent upon a fair and sympathetic solution of the problem—a solution which will take account of the mentality and culture of the native populations as well as of the modifications in custom and outlook which have been forced upon them by contact with European civilisation.

BESIDES detailing the work carried out in the Museum itself during 1924, the Report of the Director of the Bernice P. Bishop Museum (Honolulu, 1925) gives an account of several expeditions by sea. A party on the mine-sweeper *Tanager* made a re-survey of Necker and Nihoa Islands, especially of the ancient building sites. The mine-sweeper *Whippoorwill* made two trips: the first to Fanning, Christmas, Jarvis, and Washington Islands, near the Equator in long. 157°-165° W.; the second to Baker and Howland Islands, long. 175° W. Some of the same islands, as well as Malden and Toagareva Islands and Tahiti, were visited by representatives of the Museum on board the *Kaimiloa*, a four-masted schooner with accessory oil-power, as guests of Mr. and Mrs. M. R. Kellum. On these expeditions many ethnological observations were made and large collections obtained for future study in the Museum. A botanical survey of Hawaii and the preparation of a Hawaiian dictionary are among the more important works being undertaken by this active Museum.

ON April 15, according to an announcement of the Smithsonian Institution, Mr. Henry B. Collins, assistant curator of the National Museum, left Washington to explore the tract of the Louisiana coast westward from New Orleans, which was the camping grounds of the Attacopa and Chitimacha Indians, about whom it is stated nothing has ever been written. The Attacopa were one of the few cannibal tribes of the American continent, though it is not known whether the practice was followed for ceremonial or other reasons. The Chitimacha were a people of much higher culture than the Attacopa, and seem to have been related to the Natchez. They had the same caste system, which descended through the mother, and their language was similar to that of the Natchez. Mr. Collins's work will be directed specially to the investigation of the mounds with the view of ascertaining whether they are true mounds or shell heaps. On completion of his work here he will proceed to the Mississippi Valley to continue the work of exploring the Choctaw mound which he began last year.

DURING the past few years there has been much discussion concerning the merits of the Spahlinger treatment of tuberculosis. This treatment consists in the use of a vaccine, analogous to tuberculin, and of a serum consisting of a mixture of anti-serums prepared with various strains of the tubercle bacillus and other organisms The Science Committee of the British Medical Association has summarised the known details of the preparation of the agents and of the effects of the anti-serums in the *British Medical Journal* (April 24, 1926, p 755), and points out that the exact methods of preparation have never been fully published, and that, therefore, the remedy is of the nature of a "secret remedy." It is also pointed out that no investigations, carried out under strict experimental conditions which afford direct and convincing evidence of the curative action of the remedy, have been published.

THE inter-relationship of food, health, and strength is discussed by Sir Arbuthnot Lane in an article in the *Quarterly Review* for April. While fresh air is undoubtedly important, though animals and primitive natives disregard it, right food seems vastly more important to men and animals Much of our food nowadays is soft, de-vitaminised, de-mineralised, chemically-coloured and preserved, and highly spiced. Failure to use our strong jaws, powerful jaw muscles, and teeth by the consumption of soft stuff, swallowed without chewing, results in the receding jaw, the narrow nose, weak throat, decaying teeth, toxic gums and tonsils. The capacity of the stomach and bowel clearly indicates that man was intended to live on bulky, not concentrated, food. A 'tablet' diet is an absurdity. Only a well-filled bowel readily empties itself; a sluggish bowel means stagnation and putrefaction of its contents and absorption of poisonous products. A far-reaching reform is necessary; we must go back to sound natural food; and this is one of the objects of the New Health Society founded by the writer.

THE extensive development of agricultural planting enterprises in Ceylon during the last hundred years has been accompanied by a voluminous literature, much of which is widely scattered and difficult to trace without undue expenditure of time. This has led to the publication by T. Petch of a "Bibliography of Books and Papers relating to Agriculture and Botany to the end of the Year 1915" (*Peradeniya Manuals*, 3, 1925), consisting of a list of more than five thousand references to the two subjects, exclusive of entomological work. Much care has been devoted to its compilation, and it is believed that the list is almost complete. The literature is classified under subjects, but there is no general alphabetical list of all the references. The bibliography should be of special value to all interested in tropical agriculture and botany, as it is stated that the literature of Ceylon on these subjects provides a mass of information rarely equalled in any tropical country.

MR. HENRY WOODS, of the Sedgwick Museum, Cambridge; Dr. Cyril Fox, Keeper of the Department of Archæology in the National Museum, Cardiff, and Ald. Edward Wooler of Darlington, have recently been elected honorary members of the Yorkshire Philosophical Society.

AN International Congress for Applied Mechanics will be held at the Federal Technical University, Zurich, on September 12-18 Prof E Meissner will be glad to receive the names of those who propose to attend. The titles and an abstract (not exceeding 300 words) of any paper offered for presentation at this Meeting should be forwarded to him at the University not later than June 1. Lectures have been promised by Prof. P. W. Bridgman of Harvard, Prof. P Debye of Zurich, Prof. T. Levi-Civita of Rome, Prof. L Prandtl of Gottingen, and Prof. G. I. Taylor of Cambridge, among others.

THE report of the National Baby Week Council for 1925, recently received, gives an account of the finance and activities of the Council and the results of the competitions for that year. "Baby week" in Great Britain is being organised this year on July 1-7, and a leaflet instructing how to organise a baby week celebration may be obtained from the Secretary of the Council, 117 Piccadilly, London, W.1.

THE Smithsonian Institution of Washington has in view the preparation of a descriptive account of the plants of all Central America. Dr. Paul C. Standley, botanist of the National Herbarium, has just returned from Costa Rica with a collection of nearly twelve thousand plants, including two thousand orchid specimens He is now preparing a memoir on the flora of Costa Rica, whilst the Smithsonian Institution is seeking funds to prosecute botanical exploration in Honduras and Nicaragua, two regions as yet very inadequately worked.

THE next award of the Fondation George Montefiore, which is given triennially for the best original work bearing on scientific progress and on the advancement of technical applications of electricity, will be decided in 1927. The latest date for the receipt of competing works is April 30, 1927, and they should be addressed to the Secrétaire-archiviste de la Fondation George Montefiore, Association des Ingénieurs électriciens sortis de l'Institut électrotechnique Montefiore, rue Saint-Gilles, 31, Liége. The prize, which may be divided, will be worth 20,500 francs, and is awarded by an international jury of ten, five of whom are Belgian electrical engineers.

THE German Scientific and Medical Association met in 1924 at Innsbruck; last year there was no meeting. This year the Association meets at Dusseldorf on September 19-26. Preliminary announcements are dated April, and the detailed programme is expected in July. Invitations are extended to all scientific workers and doctors of German speech and to all who appreciate German character and learning. There is also to be an exhibition of hygiene, social welfare, and physical exercises. The general sessions and chief group sessions are already planned. The main topic is scientific research in relation to industry; other matters for discussion are vitamins, capillaries, goitre, non-ferrous metals, noxious animals, quantitative spectrum analysis, luxury-poisons, synthetic anti-malaria drugs. There are fifteen scientific sections, including physical chemistry, pharmacy, genetics, eugenics, mathematical and scientific education, as well as other titles familiar at the British Association. The medical sections are nineteen in number. Correspondence should be addressed to Buro der 89 Versammlung der Gesellschaft Deutscher Naturforscher und Aerzte, Dusseldorf, Schliesfach, Nr. 66.

THE Italian Ministry of Aeronautics has issued a small *Annuario* for the use of aviators. It contains tables of the rising and setting of the sun and moon and other astronomical information, besides tidal, magnetical, and meteorological information likely to be of value in aviation. The latter half of the book gives the position of wireless stations, wave-length, call letters, and times of transmission of weather bulletins. The book is well arranged in a handy form suitable for ready reference.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A lecturer in philosophy in the University of Liverpool—The Registrar (June 1). An assistant lecturer in engineering at the Cardiff Technical College—The Principal (June 5). A lecturer in mechanical and structural engineering at the Regent Street Polytechnic—The Director of Education (June 7). A reader in mathematical analysis in the University of Leeds—The Registrar (June 9). Lecturers in palæontology, plant physiology, and comparative anatomy in the Egyptian University, Cairo—The Minister of Education, Cairo (June 14). A lecturer in tinctorial chemistry and dyestuffs, and a lecturer in bleaching, dyeing, printing, and finishing at the Manchester Municipal College of Technology—The Registrar (June 21). A lecturer in mathematics at the Northampton Polytechnic Institute, St. John Street, Clerkenwell, E.C.1—The Principal (June 26). A lecturer in biology at the Cheshire School of Agriculture, Reaseheath, Nantwich—The Principal (June 26). A principal of the L.C.C. School of Engineering and Navigation, High Street, Poplar—The Education Officer, (T.1.a), The County Hall, Westminster Bridge, S.E.1 (June 30). An assistant in archæology in the National Museum of Wales, Cardiff—The Director (July 9). A professor of Indian economics in the University of Madras—The Registrar, Senate House, Chepauk, Madras (July 30). A full-time teacher of physics and electrical engineering at the Leicester College of Technology—The Registrar. A lecturer in geography and nature study at the Bedford Training College—The Principal.

Our Astronomical Column.

SUN'S ROTATION PERIOD AS DETERMINED FROM AURORÆ.—It has long been recognised that auroræ and magnetic storms tend to recur after a synodic rotation of the sun. Mr. G. J. Burns, director of the zodiacal light and auroræ section of the British Astronomical Association, contributes a paper to the March issue of the journal of the Association, in which he discusses the auroræ from 1860 to 1921. When these are grouped in ten-year periods and separated into the four quarters of the synodic period (assumed after Carrington as 27.275 days), the maximum and minimum values shift one quarter of a rotation each ten years, indicating that the rotation period should be increased by 0.02 day. This is quite a small amount, considering the large variations in rotation period in different latitudes. It could be explained by assuming either a slightly different level or a slightly different latitude for the regions of the sun that contribute most actively to visible spots and magnetic disturbances respectively.

THE ROTATION OF VENUS.—The rotation period of Venus is still one of the enigmas of the solar system. Prof. W. H. Pickering in 1921 was led to announce a period of 68 hours about a highly inclined axis. Mr H. McEwen, director of the Mercury and Venus section of the British Astronomical Association, contributes a paper to the March issue of the journal of the Association, in which he describes some observations that support the Pickering period. Six drawings are reproduced, made between April 9 and 15, 1924; they show several light and dark streaks, which appear to turn about an axis near the centre of the disc. The periods deduced for the different markings varied from 66 to 77 hours. The definition was good on all the days. There is, of course, a large amount of evidence, notably that of Schiaparelli and Lowell, in favour of a longer period. The Mt. Wilson spectroscopic results were considered to indicate 15 days as a minimum. But the problem is such a difficult one to settle, that all evidence by skilled observers should be carefully considered.

MOTION OF SUNSPOTS IN LATITUDE.—A letter received from R. Sekiguti, Imperial Marine Observatory, Kobé, directs attention to a research on the motion of sunspots in latitude of which full details will be given in No. 2 of vol. 2 of the *Memoirs of the Imperial Marine Observatory*, now in press. An analysis of latitude motions of spots was recently published by the Royal Observatory, Greenwich, in *Mon. Not. R.A.S.*, Dec. 1924, in which no systematic drift so large as 0·1° per solar rotation was found, by considering long-lived spots during the period 1874–1923. Mr. Sekiguti, by limiting his analysis to spots of recent formation, considers that during the early phase of their life-history, spots in lower latitudes have an equatorward movement when their longitudinal drift (referred to the average motion of stable regular spots) is westward; *i.e.* in the direction of the sun's rotation. His conclusions are based on the following table from statistics of the last spot cycle:

Daily Motion in Latitude	Frequency.			
	Eastward		Westward.	
+0·5°	74	657	89	723
+0·4	58		68	
+0·3	133		135	
+0·2	162		180	
+0·1	230		251	
0·0	361		377	
−0·1	230	634	264	890
−0·2	152		215	
−0·3	149		182	
−0·4	39		89	
−0·5	64		140	

Such motions in latitude, Mr. Sekiguti says, besides throwing light on the properties of a spot vortex, may explain the equatorial inclination of the axes of bipolar groups pointed out by Hale and others.

Research Items.

A Tasmanian Aboriginal Skull.—A skull of a young Tasmanian aboriginal female discovered on the north-east coast is described by Mr. H. H. Scott, Curator of the Launceston Museum, and Dr. R. McClinton in the *Papers and Proceedings of the Royal Society of Tasmania* for 1925 The skull, which is in sound condition but lacks the mandible, indicates the age by the non-erupted wisdom teeth and the condition of the sutures. The inion is slightly developed only. Of several wormian bones the most striking is a divided "Inca bone." Like some skulls of other lowly races it shows a last relic of the external plate of the old pre-frontal in the "orbital process of the sphenoidal turbinate bone." The palate is a perfect horse-shoe shaped cavity, the lingual aspect of the tooth-line slightly widening as it goes backward, in marked contrast to the straight tooth-line in the gorilla. There are seventeen teeth in the skull, of which fourteen had erupted during life. The third pair of molars was on the eve of eruption. The effect of coarse food has begun to be apparent. Except for an abnormal molar, all the teeth are physically perfect and without structural defect. There are large pulp canals and an absence of bone absorption. The palatal arch of this and four other female and six male skulls available to the authors more nearly resemble the Mousterian outline given by Dr. W K. Gregory in his "Origin and Evolution of Human Dentition" than they resemble his Tasmanian palatal arch (Keith), though that of an eleventh skull, that of "Cobia," the lowest and most debased Tasmanian native, is more gorilla-like and generally conforms to Keith's figure.

The Jewish Calendar.—Mr. W. A Heidel contributes to vol. 61 of the *Proceedings of the American Academy of Arts and Sciences* a study of the Jewish calendar in which he arrives, by different methods, at conclusions virtually in accord with the results of the well-known authority, Dr. Julian Morgenstern. Taking it as axiomatic that the calendar is connected with cultus, there would appear to be three calendars, or preferably three phases of the calendar, in Jewish history. A convenient starting-point is the reform of Josiah in 621 B.C., which aimed at a centralisation of the cultus at Jerusalem, superseding a number of local shrines of primitive usage, each doubtless with different calendars. The first indication of a change in the calendrical system after Josiah is in Ezekiel, who dates his vision of the Temple on New Year's day, the 10th day of the month. This obviously implies an equation between two calendars—almost certainly one solar, the other lunar—the latter being the pre-exilic Israelite or current Babylonian calendar. In like manner the 10th day of a month equated with a first day of some 'New Year,' links up with the Jubilee, the Day of Atonement, Sukkot and Pentecost. The calendar to which the 'first day' belongs is clearly the sacred calendar *par excellence*. The new system of numbering of the months, the neglect of lunation in the Torah, and the Bible, and other considerations also point to a solar year In all probability it was introduced from Egypt somewhere between 610 and 605 B.C. After the Captivity there is evidence that proximity and similarity to the Babylonians led to the adoption of new festivals and of a luni-solar year, and the calendar of the Reformation was forgotten or misinterpreted It would appear, therefore, especially in the light of the evidence afforded by the dating for the feast celebrating the Exodus before the Reformation of Josiah, that the Jewish calendar was essentially luni-solar, became solar for a short time after the Reformation of Josiah, and then reverted to luni-solar, although the calendrical arrangements adopted under the solar calendar for the Church year have persisted down to the present day.

Hydrography and Plankton at Millport.—The Annual Report (1924-25) of the Scottish Marine Biological Association on the work done at the Millport Laboratory on the Clyde, drawn up by the executive of the Council, shows a satisfactory progress in all directions. The research carried on by the permanent staff includes hydrography by Mr. A. P. Orr and plankton investigations by Miss S. M. Marshall. Mr. Orr is investigating the Clyde Sea area systematically with regard to the hydrogen-ion concentration and oxygen, nitrogen, phosphate and silicate content throughout the year. Miss Marshall has published elsewhere three papers on her plankton work, including the description of the interesting new dinoflagellate *Protoerythropsis vigilans*, and a systematic study of the food of the copepod, *Calanus finmarchicus*. In the present report she describes the feeding and reproduction of the aberrant silicoflagellate *Ebria tripartita*, which is holozoic, and also gives notes on other members of the microplankton collected in the lochs. She finds that when diatoms and certain small dinoflagellates occur in a loch to any extent, they increase in numbers towards its head, where they may be very numerous. This seems to fit in with the abundance of silicates found at the loch heads, a rapid growth probably taking place where the silicates are poured in from the streams Mr. R. Macdonald, Carnegie research student, is working on the euphausiids of the Clyde area A table of the food of *Meganyctiphanes norvegica* during several months includes copepods, diatoms and other algæ besides vegetable debris.

Siliceous and Horny Sponges.—Prof. H. V. Wilson describes (*U.S. Nat. Mus., Bulletin* 100, 1925) the siliceous and horny sponges collected by the U S. Fisheries steamer *Albatross* during the Philippine Expedition, 1907-10. His account is also "something of a guide to the contemporary taxonomy of sponges, more especially of the tetraxonid sponges." He directs attention to the bearing of variations on classification in such genera as Donatia and Tetilla—the problem which meets workers on groups of plastic organisms In Donatia, for example, the various diagnostic features which have been picked out as characterising natural races all vary, and they vary apparently independently of one another, so that many kinds of combinations come into existence. Moreover, it is not a case of relatively unalterable characters (unit characters) which are present or absent, but any one feature varies so as to produce a series the extremes only of which contrast sharply; thus as the number of carefully studied individuals increases, the intergrading makes more and more difficult the customary method of classification, which is essentially a splitting method. He advocates the formation as sub-genera, not as groups into which all the species of a genus are divided, but rather as groups which are sufficiently homogeneous to be set off from a still heterogeneous remainder. If, therefore, a character or combination of characters is distinctly developed in a particular case the latter would find its place in a sub-genus in the sense proposed, but if such features are absent or not well marked, the specimen would be placed in the body of the genus (*e.g.* Tetilla).

Mitochondria in Opalina.—E. S. Horning (*Australian Journ. Exp Biol*, vol 2, Dec. 1925) has investigated the mitochondria which are present in large numbers in Opalina at all stages of the life cycle. In the asexual multiplicative phase of Opalina the mitochondria are bent, filamentous bodies and they multiply by longitudinal fission. Immediately before the Opalina encysts the mitochondria may divide transversely, giving rise to spherical bodies which persist in the cyst and in the gametes. In the zygote they appear to fuse into larger masses which later break up into small granules; these in turn elongate to form the filaments of the asexual stage. The author considers that his observations afford strong evidence for the view that the mitochondria are persistent, self-reproducing bodies, and not metabolic products of the cytoplasm, though the latter possibility has not been disproved. Further, he adds that synthesis of vegetative granules—storage products—appears to take place at the surface of the mitochondria, an observation which gives support to the speculation that the mitochondria are loci of protein and possibly of general protoplasmic synthesis within the body of the living cell.

Ice in the Baltic.—The Havsforsknings Institutet of Finland has published the annual report on ice in the Gulf of Bothnia and Finland (*Isarna Vintern*, 1922–23). From about 120 stations, including several on the Finnish coasts of Lake Ladoga, detailed observations are given for the winter months. Not until January did ice become a serious menace. By early February all the Baltic coasts of Finland were blocked and the Gulf of Finland was very congested. By the end of the month pack-ice extended past the Åland Islands across to the Swedish coast, and the head of the Gulf of Bothnia was inaccessible. Conditions were even worse in March, and the spring break-up was very slow. In the beginning of May there was still ice in the north of the Gulf of Bothnia and at the head of the Gulf of Finland. It was June before the former entirely disappeared. These conditions, except the slow disappearance of the ice, did not show a marked departure from the normal, but the winter was on the whole a severe one.

The Plant as a Measure of the Habitat.—The discussion of the 'phytometer' method by Clements and Goldsmith was recently referred to in this journal (Nature, Oct. 31, 1925, p. 656). Two recent papers record South African studies on these lines. Mr. J. F. V. Philips has been using the growth and structure of indigenous tree seedlings, both naturally sown and specially planted in selected quadrats, in order to obtain a quantitative expression of the effect of the habitat (*South African Journal of Science*, vol. 22, pp. 197–214, 1925. See also Nature, January 2, p. 16). Prof. J. W. Bews and Dr. R. D. Aitken, with the collaboration of advanced students of Natal University College, have issued a second series of the researches on the vegetation of Natal (*Memoir No.* 8, the Botanical Survey of South Africa, Pretoria, 1925), which includes a study of the water requirement and transferation of a common Natal weed, *Bidens pilosa* L. These studies were undertaken with the view that the behaviour of this universally distributed Natal weed under carefully controlled habitat conditions is a necessary preliminary to its employment as a 'phytometer.'

Silver Leaf Disease.—Mr. F. T. Brooks continues at Cambridge his investigations into this serious disease of fruit trees, especially apple and plum, and in association with Mr. W. C. Moore publishes a fifth paper upon the subject in the *Journal of Pomology and Horticultural Science* (vol. 5, No. 2, March 1926). One of the most striking results reported is the almost complete failure of inoculation with spores of *Stereum purpureum* upon freshly cut surfaces of healthy trees in the months of June and July, and sometimes in August. These results are in striking agreement with Mr. Swarbrick's investigations upon the natural processes of healing in such cut trees (Nature, May 1, p. 635), recorded in the same journal. As Mr. Brooks finds that the disease makes little entry, if any, by old wounds, or through diseased tissues produced by other pathogenic organisms, these results seem to be of great practical significance. Indeed, in discussing treatment, the authors conclude that there is now ample evidence that the winter thinning and pruning of fruit trees is fundamentally wrong from the point of view of plant pathology. The authors report further trials with various protective dressings, applied immediately to cut surfaces. Gas tar and Stockholm tar seem to be ineffective; soft grafting wax is most highly recommended. Apparently its great value lies in the fact that it does not injure the tissues; apart from this danger certain anti-fouling paints appear to be very satisfactory. In view of the inoculation experiments reported in the same paper, it would seem that if the cut surfaces are exposed at a suitable season, natural healing processes themselves are usually an adequate protection against the entry of *Stereum purpureum*.

Subsidence of Coral Reefs.—In the *Proc. Nat. Acad. Sci.*, Washington, for February 1926, Prof. W. M. Davis brings forward additional evidence in favour of the strong subsidence of certain reef-encircled islands. It is argued that during intermediate stages of the submergence of a maturely dissected volcanic island, the distance from the island top to the outer spurs (spur-radius) should be two or three times the distance between the heads of bays and the outer spurs. Some of the embayed islands of the Fiji and Society groups, tested by this new criterion, appear to have subsided 1000 or 2000 feet. Similarly, where the width of the lagoon and the spur-radius are of the same order, the encircling reef must have been built up from a considerable depth. It is also ingeniously shown that the rate of island submergence in the open Pacific is frequently not faster than that of reef upgrowth. This implies that the rate of reef upgrowth is significantly slower than that of coral upgrowth, since the growing corals are the chief source of supply not only for the reef face itself, but also for the reef flat, much of the lagoon floor, and the outbuilding of the outer talus slope. The relation of island subsidence and reef upgrowth to changes of ocean level during and after the glacial period is also briefly considered.

The Age of Uranium Minerals.—Analyses of pitchblende from Katanga, uraninite from the Black Hills of South Dakota, and asphaltite from Utah have been made by C. W. Davis, and they are recorded and discussed in the *Am. Journ. Sci.* for March 1926. The Katanga specimen is of particular interest in being quite free from thorium. It therefore helps to confirm the theory that thorium and uranium are not genetically related. The lead-ratio is 0·084, which is identical with that of polycrase from Brazil and with the higher ratios from Ceylon thorianites. The dolomite schists of the southern Belgian Congo are now known to be older than the age corresponding to this ratio, but unfortunately it is not yet certain whether that ratio characterises the older Palæozoic or the latest pre-Cambrian. Determinations on minerals of Keweenawan age now being carried out in the United States should definitely fill up this gap in our present knowledge. The Black Hills uraninite contains lead having an atomic weight of

206-07 (determined by Dr. A. L. Hall of Harvard). The geological age is pre-Cambrian, but the lead ratio, 0·24, is abnormally high. As the specimens are all somewhat altered to gummite and uranophane, the result is in accordance with the view advocated by Holmes, that altered uranium minerals tend to gain lead in greater proportion than they lose uranium (*Phil. Mag.*, May 1926). The asphaltite gives a low age and indicates, as deduced from geological evidence, that the deposit has been carried upwards and redeposited by thermal waters, during which most of the accumulated lead was dissolved and removed.

Diffraction Phenomena with Biological Structures.—Adrianus Pijper has demonstrated (*South African Med. Record*, October 24, 1925) that surface growths of various bacteria act as diffraction gratings, and a study of the spectra obtained by means of such ‘ gratings ’ leads to the conclusion that bacilli in the culture probably stand on end perpendicular to the surface. By projecting the spectrum obtained into a dark chamber and focussing on a screen, measurements of the circular images may be made which, by the aid of a simple formula, give the size of the structures forming the grating. In this way the diameters of the microbes constituting the grating may be calculated. Blood smears also act as diffraction gratings, and the average size of the blood corpuscles can be calculated in a similar manner. In pernicious anæmia there is an increase in the average size which can be demonstrated by the method, which, therefore, may be employed for certain clinical investigations. Full details of the technique are given.

Optical Effects in Invertebrates due to Guanin.—The recently issued *Verhandlungen des Naturhistorischen Vereins der preussischen Rheinlande und Westfalens* (82 Jahrg) is dedicated by his friends and pupils to Prof. Walter Voigt of Bonn, for many years secretary of the Verein, in honour of his seventieth birthday. It contains a score of zoological papers and three on geological subjects. Two of the zoological papers record the occurrence of guanin in reflecting structures in invertebrates. J. Schlicher describes the tapetum—using this term for the iridescent layer—in the eye of *Pecten jacobæus* as composed of crystalline quadratic plates, about 1·4 μ in diameter, which are arranged in superimposed layers and in rows. These plates consist of guanin. He states that the layer contains from three to six cell nuclei of characteristic structure. W. J. Schmidt has examined the iridescent males of two Mediterranean species of Sapphirina, and shows that the iridescence is dependent on the epithelium of the dorsal surface, the cells of which attain a large area but are very thin. These cells secrete the cuticle, and they also produce in their cytoplasm the layer which gives rise to the iridescent effects. This consists of hexagonal plates about 1 μ in diameter and 0·3 μ thick, arranged in three systems, and they are either composed of guanin or contain a guanin component.

Liquid Viscosity under Pressure.—The February issue of the *Proceedings of the American Academy of Arts and Sciences* contains a paper by Prof. P. W. Bridgman of Harvard on the effect of pressures up to 12,000 atmospheres on the viscosities of forty-three liquids, mainly organic, at 30° C. and 75° C. The method used is that of the falling weight, which in this case is a short cylinder nearly filling a steel tube 0·6 cm. internal diameter and about 6 cm. long placed vertically. The time of fall, 5 to 50 seconds, is determined by means of electrical contacts at the top and bottom of the tube, which can be inverted between each fall. Except for water, the viscosity increases with the pressure, at first according to a linear law, but at higher pressures the increase becomes more rapid. The total increase at 12,000 atmospheres may be 10-fold or 10-million-fold, the larger values being found for liquids with complicated molecules. The effect of temperature on the viscosity is several times as great at 12,000 atmospheres as it is at 1 atmosphere. The viscosity of water decreases a few per cent. as the pressure increases up to 1000 atmospheres, then increases, and at 12,000 atmospheres has about twice the value it has at 1 atmosphere.

The Lightning Flash.—Some fifty years ago a lightning flash was supposed to take place along the path of minimum electric resistance Afterwards Lodge gave reasons for supposing that it followed the path of minimum electric inductance, and this is the orthodox theory at the present time. In a paper communicated to the Washington Academy of Sciences (vol. 16, p 87), N. E. Dorsey describes in detail the effects produced by a flash striking a tulip tree. He considers that these effects could have been produced by a great rush of ‘ carriers ’ analogous to the well-known cathode stream. If an electron attain a sufficiently high velocity it may generate a ‘ dart ’ of electrons, the leading electrons gaining energy at the expense of the trailing ones. A high-speed dart possesses a considerable amount of momentum, and can strike a correspondingly powerful blow. In the particular case studied, the molecules were so crowded that they could not pass transversely to the grain without actually punching out the fibres ahead of them. Along the grain, however, in the direction of the flow of the sap, they could pass much more easily, but in so doing the fibres were torn into shreds.

What happens during a lightning flash Dr. Dorsey describes as follows. There is at first a rush of electrons. These blaze a conducting path along which flows a more leisurely current of the ordinary type. Possibly this conducting current conveys a far larger quantity of electricity than is carried by the dart of electrons. The direction in which the dart flies is the direction in which the blow is delivered. The effects produced where the stroke starts differ characteristically from those produced where it ends.

Electric Ignition of Firedamp.—The Safety in Mines Research Board has issued a paper by Prof. R. V. Wheeler on the electric ignition of firedamp which is of considerable interest. The results do not agree with the researches of some other workers in this field, and further experiments are being undertaken in an attempt to reconcile them. It is proved that the igniting current for a given mixture of methane and air varies directly with the volatility of the metal at the spark-gap, being lower the lower the boiling point of the metal. The igniting current also is lower the more rapid the break in the circuit. It is also lower the less the area of the surfaces which touch one another and are pulled apart. Prof. Wheeler was unable to find any simple law connecting the value of the igniting current with the inductance of the circuit. In a particular case, a simple particular law was found which seemed to indicate that the electromagnetic energy stored in the circuit was approximately constant for the minimum igniting current. With highly self-inductive circuits the magnitude of the current is of far greater importance than the impressed voltage when the voltage is low. But with high voltages the igniting current decreases with the voltage. Finally, the experiments seem to prove that the incendivity of the break flashes does not depend on whether the current is direct or alternating.

A Problem in South African Geology.

THE Vredefort Mountain Land lies to the west of Vereeniging and some eighteen miles south-south-west of Johannesburg; it is cut through by the Vaal River, which forms the boundary between the Transvaal and the Orange River Free State. Its striking topography, in marked contrast to the monotonously flat country of the northern Orange River Free State, is determined by an enormous circular boss of granite with some gneiss and schists, about twenty-seven miles in diameter. This granite boss is surrounded by a belt of sediments ranging from the Lower Witwatersrand beds (nearest to the granite) up to the Pretoria beds—in all some 13,000 feet of total thickness. Although in apparently conformable succession, the beds dip towards the granite instead of away from it, as they should do if the succession were normal; so that there is here an inversion of the strata on a very large scale. Near the granite the sediments are highly metamorphosed, the shales and slates being charged with contact minerals. These phenomena constitute a fascinating problem, which has exercised the minds of South African geologists since the earliest days of the Rand.

The granite (a quartz-orthoclase-oligoclase-biotite rock) is generally accepted as identical with the old granite occurring north of Johannesburg and near Heidelberg, and as older than the Witwatersrand beds It cannot therefore be intrusive in them, and the problem requiring solution is: What brought about the tilting and inversion of the sediments encircling the granite? And what is the cause of the contact-metamorphism shown by them?

The memoir under review[1] embodies the work done by Dr Molengraaf, professor of geology in the Technical High School, Delft, and Dr. Hall, assistant director of the Geological Survey of the Union of South Africa, to elucidate this problem The authors first review the various theories put forward in papers by Gibson, Molengraaf, Draper, Bunkell, Hatch, Sawyer, Jorissen, Kynaston, Mellor, and Penny, and then, after a detailed geological and petrographical description of the rocks and their tectonic history, they state their conclusions, which may be briefly summarised as follows:

(1) The granite is older than, and therefore non-intrusive into, the sediments.

(2) The over-tilting of the sediments is due to the up-doming of the central granite, which, it is suggested, was initiated by centripetal pressure. The relief of load resulting from this movement caused a younger magma below the granite to become active and to rise, thus assisting the upward movement of the heated but passive granite

(3) This up-doming called into play exceptionally powerful pressure which manifested itself both in the metamorphism of the encircling sediments and in the production, by compression, trituration, and local fusion, of a flinty crush-rock (pseudo-tachylyte) which occurs in countless veins both in the granite and in the encircling sediments.

(4) In the contact-belt are dykes of enstatite-granophyre, which contain numerous xenoliths of crushed quartzite derived from the Lower Witwatersrand beds. It is suggested that this apparently igneous rock is a flinty crush-rock originating from ultra-trituration and partial fusion of the sediments.

(5) The metamorphism of the sediments was, in part, *regional* and due to static pressure, accompanied by heat, and, in part, *local* and due to the emplacement of a large younger intrusion.

(6) The regional metamorphism is characterised by the production of hornblende-granulite and garnet-amphibole-hornfels; the local metamorphism, by cordierite-biotite-hornfels and andalusite-biotite-hornfels. Where the two are concurrent the reinforced metamorphism is indicated by the increased size and abundance of the contact-minerals

(7) The younger intrusion, referred to in (5), is, to a great extent, concealed, although exposed as three small bosses of alkali-granite (soda-granite) and accompanying nepheline-syenite dykes. Certain gabbroic marginal intrusions in the older granite and the nearest belt of sediments are regarded by the authors as the earliest basic differentiates of the younger magma

(8) The extension of the nepheline-syenite dykes northward across the Magaliesberg into the Pilandsberg (also a region of alkali-rocks) indicates the existence of channels of communication between the two centres of alkali-rocks and some community of origin with the Bushveld complex.

The Vredefort Mountain Land has, according to the authors, remarkable analogies with the Black Hills dome in Dakota and the Ries Kessel in Bavaria In the Vredefort area the up-doming movement originated at a greater depth than in the Black Hills dome; and this explains why the regional and contact metamorphism are so much more developed in the Vredefort area. Stress phenomena are much in evidence both in the Vredefort and the Ries domes, but in the former they attain a marvellous development, culminating in the genesis of flinty crush-rocks on a gigantic scale In all three cases the observed facts lead to the surmise that a hidden mass of igneous magma must be present below the central core of granite.

F. H. HATCH.

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[1] "The Vredefort Mountain Land in the Southern Transvaal and the Northern Orange Free State" By Dr A L Hall and Prof Dr. G. A. F. Molengraaff Shaler Memorial Series. (Verhandelingen der Koninklijke Akademie van Wetenschappen te Amsterdam (Tweede sectie), Deel 24, No. 3) Pp xiv+183+39 plates. (Amsterdam: Koninklijke Akademie van Wetenschappen, 1925) n p

Sunspots and Terrestrial Magnetism.[1]

FOR a long time it has been known that sunspot frequencies have had their counterpart on the earth in the disturbances exhibited by the magnetic elements on its surface As the sunspot period is at least eleven years, and as the variations in sunspot phenomena in successive eleven-year periods are considerable, it follows that to get a comparison of normal means free from accidental effects, a large number of periods must be taken. The Kew magnetographs have been in almost continuous operation since 1858, and the connexion between sunspots and the absolute daily range of declination (the element most easily measured), for the first 42 years of their progress up to 1900 has already been discussed. The first of the memoirs under notice treats of the same phenomena and adds another 10 years to the comparison (1) The decade which is under discussion proved generally to be one of small magnetic disturbance and low sunspottedness. Anomalies were disclosed in 1903 and 1909, but were attributed to accidental magnetic disturbance enhancing what would otherwise have been normal years. The application of Wolf's formula, connecting magnetic range with sunspot numbers, also gives a small amplitude of the declination range corresponding to hypothetical zero sunspot numbers throughout the ten years.

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[1] Air Ministry, Meteorological Office, London. (1) Geophysical Memoirs, No. 29 *The Absolute Daily Range of Magnetic Declination at Kew Observatory, Richmond*, 1901–1910, by J. M Stagg. 3*s.* net (2) Geophysical Memoirs, No 30. *Comparison of Magnetic Standards at British Observatories, with a Discussion of Various Instrumental Questions involved*, by Dr C Chree. 1*s.* 6*d* net (Published by the Authority of the Meteorological Committee.) H.M. Stationery Office, London.

Generally speaking, the results obtained are parallel with those for the previous longer series, especially in regard to the annual variation in daily range, and the incidence in the times of daily maxima and minima. The progressive change in time of the maximum daily value of declination was of the same sign, although not attaining the same order of magnitude as was suggested for the earlier periods. Confirmatory evidence is also shown of the 27-day period of recurrence of magnetic disturbance and calm, corresponding with the period of rotation of the sun.

The memoir concludes with a comparison between the inter-diurnal variability of sunspot areas and declination ranges, which does not remove the anomalies of 1903 and 1909. To facilitate examination, the numerous tables are represented diagrammatically. Mr. Stagg is to be commended on undertaking a task involving much tedious measurement of curves and a vast amount of laborious arithmetic.

(2) In order to get a correct idea of local variation and secular change in the components measured in terrestrial magnetism, one must be assured by careful comparison that the differences between individual standard measuring instruments do not confound the issues. Owing to his long experience in testing magnetic instruments, and his intimate knowledge of the standardisation of magnetographs, no one was better fitted than Dr. Chree for carrying out the comparison of the magnetic standards used at Kew, Greenwich, Eskdalemuir, Stonyhurst and Valencia, described in the second memoir. Taking the Kew instruments as ultimate standards, the instruments compared were Kew pattern unifilar magnetometers for measuring horizontal force and declination, and dip circles and inductors for the angle of dip.

Generally a travelling unifilar magnetometer and a dip circle served as intermediaries between Kew and the other stations. According to circumstances, the comparisons, extending in each case to about a week, were effected through direct simultaneous observations with two instruments, or indirectly through the medium of the magnetograph curves. Except at Stonyhurst, where the facilities for 'direct' comparison were rather limited, the differences obtained in declination and dip were trifling, and what might be expected of any two ordinary instruments over such a short period. The differences in the case of horizontal force measurements were more considerable, and no doubt had their origin in the variations of the 'constants' for which corrections have to be applied.

These 'constants' include (1) temperature, and (2) induction coefficients; (3) distribution of magnetism constants (P and Q), and (4) the moment of inertia of the collimator magnet. They have such an important bearing on the results, that the first part of the paper is devoted to a detailed discussion of the considerations which they involve. Temperature and induction coefficients are determined at the initial standardisation of the collimator magnet, and their variations are inappreciable. The 'constants' P and Q vary considerably with time, and the elimination of changes due to accidental causes is brought about by the use of means from large numbers of observations. Owing to attrition through constant use, the moment of inertia of the magnet is liable to decrease progressively, and fairly frequent determinations are desirable. The moment of inertia of the magnet is usually calculated from the mass and dimensions of its inertia bar (which should be a perfectly homogeneous right circular cylinder). Recent measurements of inertia bars at the National Physical Laboratory give the impression that modern methods of accurate measurement of length do not absolutely agree with those of the past, and the question should be investigated further.

After a perusal of the uncertainties liable to be introduced in the corrections applied, one is left with the idea that consistent true values of the horizontal force are hard to come by, but this idea is partly dispelled by an examination of the remarkably consistent base line values of the magnetograph curves obtained at Kew Observatory.

The memoir should prove of valuable assistance to all magneticians, and particularly to any one undertaking a similar investigation in the future.

R. E. Watson.

The Fauna of the Chatham Islands.

The Chatham Islands lie 536 miles east of the South Island of New Zealand and belong to that country both territorially and faunistically. They include three chief islands which are very fertile and are inhabited by a few hundred whites and natives. In *Records of the Canterbury Museum*, vol. ii, No. 3, 1925, seven out of the ten papers contained in that issue are devoted to various groups of animals occurring in these islands, and chiefly collected by Messrs. Archer and Lindsay.

The Lepidoptera are dealt with by Mr. E. Meyrick, who mentions that forty-three species have now been recorded. Of these, three are domestic insects undoubtedly introduced by the direct agency of man; one species, *Agrotis ypsilon*, is cosmopolitan; six are common to both New Zealand and Australia, but probably are all of Australian origin; twenty-four are New Zealand species; and nine species so far as known are endemic. It is believed that few of the non-indigenous species have found their way to these remote little islands by being blown out to sea, and they have probably taken advantage of human agencies in some way in gaining their entry.

The Trichoptera are described by Dr. R. J. Tillyard, and only three specimens were obtained. Two of these belong to new species that are closely allied to existing New Zealand forms, while the third specimen is of a more interesting character. It is a very remarkable short-winged caddis-fly which is referred to a new genus Chathamia and to a new subfamily of the Rhyacophilidæ, the Chathamiinæ.

Mr. A. E. Brooks discusses the Coleoptera, and remarks that, of the 110 species of beetles previously known from the islands, only twenty-four are represented in the collection made by Messrs. Archer and Lindsay. More than half the species recorded are also common to New Zealand, and only two endemic genera have been brought to light, namely, Thotmus and Hadramphus, both of which belong to the Curculionidæ. The Orthoptera and Dermaptera are very few in number, only six species being recorded by Mr. A. M. Lysacht. These include three species of so-called sand-crickets (Stenopelmatinæ), one of which is endemic; a phasmid *Argosarchus horridus* (White); a cockroach *Zonioploca brunni* (Alfk.); and the earwig *Anisolabis littorea* (White).

Prof. C. Chilton enumerates the Amphipoda and Isopoda, and of the first-mentioned order eight species are now known to occur. Of the Isopoda eight species likewise are listed, and of these the most notable is *Paravireia typicus* gen. et sp nov. This crustacean belongs to the family Sphæromidæ and is a fresh-water form. A remarkable fact concerning this type is that it is allied to the genus Vireia which occurs in underground waters in Europe. The spiders are discussed by M. Lucien Berland, who adds two species new to science, making a total of twenty species now recorded from the islands. The affinities of these spiders, he remarks, are entirely with New Zealand—they have no affinity with S. American forms.

Inheritance of Induced Melanism in Lepidoptera.

J. W. H. Harrison and F. C. Garrett (*Proc. Roy. Soc.*, B, vol. 99, p. 241, Feb. 1926) record the results of some eight years' observation and experiment upon the inheritance of melanism induced in Geometrid moths by the addition of lead and manganese to their diet. The increase of melanism among various Lepidopteran species in industrial districts of England and the Continent has excited the attention of the field naturalist and the general biologist for some time, and in 1920 Dr. Harrison made the suggestion (*Journ. Genetics*, 9, 3, p. 195) that the increase in melanism was due to the modification of the body pigments through various salts deposited on the food plants in areas where the atmosphere is charged with smoke.

This suggestion was submitted to experimental verification, and the result is the most unequivocal proof which has yet been obtained of the inheritance of an experimentally induced modification. Individuals of three species, *Selenia bilunaria* and *Tephrosia bistortata* and *crepuscularia* were used. Normal (non-melanic) individuals were obtained from rural districts of the south of England. Some of them were kept as controls on normal food and, though bred for several generations, showed no melanism. Others were submitted to experimental conditions, the *S. bilunaria* individuals being fed on hawthorn treated with lead nitrate and manganese sulphate, the *T. bistortata* being fed on roadside hawthorn gathered in an industrial district (north Durham) where there is an abundance of wild melanic forms. In both cases melanism appeared in the experimental animals, and was inherited in *S. bilunaria* and *T. bistortata* as a Mendelian recessive, in *T. crepuscularia* (p. 245) as a dominant.

The technical procedure in these experiments seems to leave no room for criticism; though we would like to hear the author's views as to why in certain cases (pp. 245 and 246) the number of animals which are experimentally modified is so low (22·1, 26:1, and 29:2). Further experiments are contemplated with the view of discovering the active agent which produces the colour change, the authors expressing a doubt as to whether it may not be the acid radical of the compounds employed instead of the metal.

A Journal of Marine Investigations.

The recent issue of the first number of the *Journal du Conseil* marks the start of a new and welcomed venture in publication by the Conseil permanent international pour l'exploration de la Mer. British readers in particular will find pleasure in the fact that Dr. E. S. Russell, the Director of Scientific Fishery Investigations of the Ministry of Agriculture and Fisheries, has undertaken the difficult task of editing this important work. The *Journal* will, it is hoped, appear quarterly, each number containing a general article on some aspect of the Council's work, one or two short scientific articles such as have hitherto been published in the *Publications de Circonstance* (which series will now be discontinued), notes on current work, reviews, and a current bibliography. The first number is a noteworthy commencement. The general article is written in English by Prof. Johan Hjort on "Fluctuations in the Year Classes of Important Food Fishes," and a résumé in French follows. The scientific article, also in English, on "The Relation between Cod-end Mesh and Size of Fish Caught" describes some preliminary experiments with the Trouser trawl, and should be of especial interest to the practical men of the trawling industry.

Thirteen papers in all are reviewed, the name of the reviewer in each case being given. It will probably be noticed that twelve of the thirteen papers reviewed were published in English, and of these nine were written by British investigators. Moreover, only two of the reviews were prepared by Continental writers. Many readers would be greatly assisted in their work if it could be found practical to include reviews of papers appearing in languages which are generally unfamiliar. If, also, the list of reviewers could be made to include representatives of the several nations interested in the work of the Council, a great store of experience and thought would become available to the readers of the *Journal*.

Part i. of a selected bibliography of marine bionomics and fishery investigation, compiled by Dr. E. J. Allen, will be generally welcomed. Part ii. is to appear in the second number of the *Journal*, and it is proposed to re-issue the bibliography, when complete, as a separate publication. Starting with No. 3 of the *Journal* the current bibliography will be issued to subscribers in the form of sheets printed on one side only, as well as being printed in the *Journal* in the ordinary way.

University and Educational Intelligence.

Cambridge.—The effects of the general strike were very marked. The Council of the Senate naturally made no recommendation as to the course which persons *in statu pupillari* should adopt. A tutors' committee dealt with instructions to those who wished to volunteer for service in various capacities; unfortunately, this committee gave instructions before an adequate organisation capable of dealing with masses of volunteers had been created. The result was semi-chaos, reminiscent of the early autumn of 1914.

The University ceased to give formal instructions between May 9 and 16. All triposes have been postponed, some for a week and some for a fortnight. As a result of this scheme the carefully devised plan on which the examinations are usually arranged in space and time has been dislocated, and the Board responsible for the organisation is faced with the prospect of providing for some 2000 candidates for university examinations on certain days (1600 is usually regarded as the maximum).

Edinburgh.—At the meeting of the University Court on Monday, May 17, an intimation was received from Prof. B. P. Watson, professor of midwifery and diseases of women, of his intention to resign upon his appointment as professor of obstetrics and gynæcology in Columbia University, New York. The Court received his intimation with regret.

LEEDS.—It has been decided to confer the honorary degree of D.Sc. upon emeritus Prof. P. F. Kendall, following professor of geology in the University.

Dr. F. M. Rowe has been elected to the chair of colour chemistry and dyeing as from October 1 next, in succession to Prof. A. G. Perkin. Dr. Rowe entered the University of Leeds from the Marling School, Stroud, in 1908 with a Clothworkers' Company's scholarship. He graduated with first-class honours in colour chemistry and obtained the Diploma in Dyeing and the Leblanc Medal in 1911. He held the Clothworkers' Research Scholarship for one year and a University Research Fellowship in the following year. After three years' experience with Messrs. Joseph Crosfield and Sons, Ltd., Warrington, he was appointed lecturer in dyestuffs in the University and the College of Technology at Manchester, and in 1926 was appointed reader in tinctorial chemistry and dyeing. He was awarded the Dyers' Company's Gold Research Medal in 1925. He is the author of a number of papers on pure chemistry, coal tar, intermediate products, dyes, and dyeing published in scientific and technical journals, and of articles in Thorpe's "Dictionary of Applied Chemistry." He is also the editor and compiler of the "Colour Index" published by the Society of Dyers and Colourists, Bradford.

LONDON.—The University chair of physiology tenable at the London School of Medicine for Women, now held by Dr Winifred C. Cullis, will henceforth be known as the Sophia Jex-Blake chair of physiology in the University of London.

Prof. J. A. Fleming, who occupies the University chair of electrical engineering at University College, will retire on July 31 next; the Senate has passed a resolution placing on record its sense of the importance of his achievements in this field of applied science.

A bequest by the late Sir John Rotton of books, bookcases, and bookshelves, and of 500*l.* for the creation of a fund to be known as "The Sir John Rotton Fund" in connexion with the Library of University College, has been accepted.

The following doctorates have been conferred:—*D.Sc.* (*Botany*) on Mr E. J. Collins for a thesis entitled "Variegation and its Inheritance in *Chlorophytum Elatum* and *Chlorophytum Comosum*," and other papers; *D.Sc.* (*Mathematics*) on Mr. G. C, Steward for a thesis entitled "Aberration Diffraction Effects," and another paper.

In consequence of the general strike, many of the University examinations have been postponed.

Dr. T. F. Sibly, vice-chancellor of the University of Wales, has been appointed Principal Officer in succession to Sir Cooper Perry, who retires on August 31.

DR. W. E. H. BERWICK, reader in mathematics in the University of Leeds, has been appointed to the chair of mathematics at the University College of North Wales, Bangor.

APPLICATIONS for grants from the Chemical Society Research Fund are invited. They should be sent, on a prescribed form, to reach the assistant secretary of the Society, Burlington House, Piccadilly, W.1, by Tuesday, June 1.

THE London School of Hygiene and Tropical Medicine, 23 Endsleigh Gardens, W.C.1, is prepared to consider applications for two whole-time research studentships, one in the Department of Tropical Pathology and one in the Department of Helminthology. Each studentship is of the annual value of 250*l.* The latest date for the receipt of applications by the Secretary of the school is June 30.

Contemporary Birthdays.

May 24, 1855.	Dr. Alfred Cort Haddon, F.R.S
May 24, 1861.	Sir Wyndham R. Dunstan, K.C.M.G., F.R.S.
May 24, 1860.	Prof. A. Smithells, C.M.G., F.R.S.
May 25, 1858.	Sir Henry Alexander Miers, F.R.S.
May 25, 1865.	Prof Pieter Zeeman, For.Mem R.S.
May 26, 1844.	Sir Daniel Morris, K.C.M.G.
May 28, 1861.	Dr. Hugh Robert Mill.
May 28, 1874.	Sir Rowland Harry Biffen, F.R.S.

DR. HADDON, reader in ethnology in the University of Cambridge, is a Londoner. He graduated at Christ's College, Cambridge. A former president of the Royal Anthropological Institute, he has received its Huxley medal for his services to anthropology

Prof. SMITHELLS, emeritus professor of chemistry in the University of Leeds, a Lancashire man, was born at Bury Educated at the University of Glasgow and Owens College, Manchester, he studied also at Munich and Heidelberg. Prof. Smithells' extended and valuable services to the University of Leeds, of which indeed he may claim to be one of the founders, have received special recognition.

SIR HENRY MIERS, vice-chancellor of the University of Manchester (an office from which he is retiring this year), was born at Rio de Janeiro. From Eton he graduated at Trinity College, Oxford. Waynflete professor of mineralogy in the University of Oxford from 1895 until 1908, he vacated this chair to become principal of the University of London Recently Sir Henry has been elected a trustee of the British Museum.

Prof. PIETER ZEEMAN, foreign member of the Royal Society, was born at Zonnemaire, Holland. He is an alumnus of the University of Leyden, and formerly held there the chair of physics. Thirty years ago Zeeman communicated a paper of prime value to the Academy of Sciences, Amsterdam, entitled "On the Influence of Magnetism on the Nature of Light radiated from a Substance." Later, in its applications to celestial physics, this contribution provided astronomers with methods for tracing magnetic effects at the surface of the sun. In 1902 Prof. Zeeman was Nobel laureate in physics, with Prof. Lorentz; in 1922 he was awarded the Royal Society's Rumford medal for his researches in optics. A medallist last year of the Franklin Institute, Philadelphia, reference may be made to Prof. Zeeman's suggestive address there, "Magnetisation of Spectrum Lines: Reminiscences and Prospects."

SIR DANIEL MORRIS, economic botanist, was born at Loughor, Glamorgan, and was educated at Cheltenham and the Royal College of Science, London. From 1886 until 1898 he was assistant director of the Royal Botanic Gardens, Kew, and afterwards Imperial Commissioner of Agriculture, West Indies

DR. MILL, geographer and meteorologist, was born at Thurso. He is a graduate of the University of Edinburgh. Librarian of the Royal Geographical Society, 1892–1900, Dr. Mill is an authority on rainfall data and meteorological statistics in general. He is the author of valuable works on polar exploration

SIR ROWLAND BIFFEN, professor of agricultural botany in the University of Cambridge, graduated there at Emmanuel College. He has actively pursued (notably in conjunction with the late Dr. W. Bateson) the general problems of heredity and variation in plants, particularly with reference to the breeding of new and valuable races of wheat. Sir Rowland was Darwin medallist of the Royal Society in 1920.

Societies and Academies.

London.

Royal Microscopical Society (Industrial Application Section), April 28.—J. H G. **Monypenny**: Some microstructural features of modern rustless steel. During the last few years several special types of stainless steel have been developed to meet special requirements. After referring briefly to the characteristic structures of ordinary stainless steel, the effects of raising still further the chromium content was described. The properties of low carbon material containing 16 to 20 per cent. chromium were discussed, particular attention being given to the solution of the carbide, the grain size, and the hardness and toughness of such material. Adding increasing amounts of nickel to such alloys restores to such high chromium steel the capacity for hardening by quenching from high temperatures and of producing tough ductile material when suitably treated. The austenitic steels produced by adding large amounts of nickel to high chromium steels were also described.

Cambridge.

Philosophical Society, May 3.—Sir Joseph **Larmor**: Insular gravity and oceanic isostasy.—W. A. D. **Rudge**: A mechanical model of the Rutherford-Bohr atom. An attempt is made to show that a rotating electron or electrons can map out a portion of space which represents the volume of the atom. This is effected by using for the electron a small electric lamp, which may be made to rotate about two axes simultaneously. Owing to persistence of vision, the track of the moving lamp appears as a continuous line, mapping out a spherical or ellipsoidal figure somewhat resembling a hollow globe with luminous lines for the meridian of longitude. A second lamp indicates the position of the nucleus. In another arrangement vacuum tubes are arranged in a plane, and by rotating about an axis parallel to the plane, the anode glows of the tubes are concentrated at the centre of a spherical space, and the cathode glows are distributed in the space surrounding the centre. This realises the usually accepted structure of the atom.—Miss C. A. Scott. On the higher singularities of plane algebraic curves. Expansions can be used to prove the numerical relations for singularities without any reference to small quantities. This is based on the theorem that if the lowest terms in $F_1(x, y)$ and $F_2(x, y)$ are of degrees r and s, then the conditions for $rs+q$ O-solutions of $F_1=0$, $F_2=0$, involve only the first q groups of terms in each, here proved by examination of the resultant of F_1, F_2 By means of this it is shown that for determining the number of O-solutions either F may be replaced by a factored form. This factored form is then applied to the proof of Plucker's equations; in particular, the number of intersections of a curve and its Hessian, at a higher singularity, is found by a direct process. No use is made of power-series and convergence.—J. A. Ratcliffe and M. A. F. **Barnett**: On the attenuation of wireless waves in short distance overland transmission. The attenuation of wireless waves of wavelengths 1600 m. and 360 m. has been measured over land up to distances of 70 miles. The results, on the whole, confirm the theory worked out by Sommerfeld, but departures from the theory are noticed at short distances. The value 10^{-8} E.S.U. is deduced for the resistivity of the ground.—Ž. **Marković**: Sur la non-existence simultanée de deux fonctions de Mathieu —C G. F. **James**: On the multiple tangents and multisecants of scrolls in higher space.—E. V. **Appleton**: On the diurnal variation of ultra-short-wave wireless transmission.—R. **Vaidyanathaswamy**: The $(a; 1)$ correspondence.

Dublin.

Royal Irish Academy, May 10.—J. **Doyle**: Observations on the staminate cone of Larix. The vascular strand of the stamen of Larix becomes mesarch distally and develops such an arrangement of transfusion tissue as to support the claim that the tissue itself is, phylogenetically, a modification of centripetal xylem. Evidence from a study of the stamens of Larix and related forms supports the claim that the stamen is not a leaf, but that the primitive stamen of the Conifer and Ginkgo phyla was a radially symmetrical structure, carrying sporangia distally attached, and of a non-foliar, axile, or sporangiophoric nature. This conception allows an easy and direct homology to be drawn between the microstrobili and megastrobili of Conifers, a point of great importance; between the different megastrobilus types themselves; and between both strobili and primitive Palaeozoic forms such as Cordaianthus. Homologising thus directly, living structures with known structures in the Palaeozoic, it renders the brachyplast conception, in any but the most refined form, untenable.—D. R. **Pack-Beresford**: The harvest spiders of Ireland. One of a series of reports submitted by the Fauna and Flora Committee. Twelve species and one variety have so far been discovered in Ireland. Almost all these have a wide range in the country. Only *Nemastoma chrysomelas* seems to be confined to the south-east. The classification adopted is that proposed by Dr. Roewer.—A. W. **Conway**: The dynamics of the spinning electron. A spinning spherical electron rotates about a fixed nucleus. The six first integrals of the equations of motion are obtained without approximation, and the motion is described. The variables are quantised, leading to a type of series term.—A. W. **Conway** and G. **Keating**: Two-electron orbits. Two electrons rotate about a nucleus of charge $+2e$, the law of force between the electrons being that of the inverse cube. Symmetrical orbits of two types are considered and quantised, leading to enhanced series terms of Rydberg type. A supplementary field of force is obtained which will give the series terms of a selected Ritz type for the helium atom and also the proper value of the ionisation potential.

Edinburgh.

Royal Society, May 10.—A. P. **Laurie**: Modern research on the methods of painting oil pictures as illustrated by the technique of the fifteenth century. The media used by artists are gum-arabic for water-colour painting, size principally for scene painting, the yolk of egg known as the tempera medium, and the three drying oils, linseed, poppy, and sometimes nut oil. The refractive indices of the drying oils are much higher than those of the other media. Brilliancy is largely due to reflection of white light, and as a pigment is immersed in media of higher and higher refractive index, the amount of white light reflected from the surface diminishes and the pigment is deeper and lower in tone. It is therefore impossible to paint in so high a key in linseed or poppy oil as in these other media. As the oil dries and the oil film gets older it turns a brownish yellow and its refractive index increases, causing a lowering of tone in the oil picture. It is therefore necessary for the painter to distinguish between the properties of the opaque and the transparent pigments and use them accordingly.

Cape Town.

Royal Society of South Africa, March 17.—A. **Ogg**: X-rays and crystal structure (Presidential address).—H. O. **Monnig**: (1) On some strongylid nematodes of the African elephant. The specimens were collected from elephants shot in the Addo Bush, Cape Province. Seven different species were found, of which four are new, namely, *Murshidia brachyscelis*; *Pteridopharynx brevicapsulatus*; *Bunostomum brevispiculum*, and *Bunostomum hamatum*. (2) Three new helminths. These are (1) *Moniezia pallida* from the horse, (2) *Spirostrongylus australis* from the red kangaroo, and (3) *Cordophilus sagittus* from cattle, koodoo and bushbuck.—A. D. **Stammers**: (1) Some observations on certain pathological changes resulting from inanition. The changes, especially in the adrenals, resulting from vitamin deficiencies in the diet, are discussed. (2) Glycolysis in blood. A discussion of the fate of sugar in the blood after the removal of the latter from the body, and an account of experiments on normal and diabetic blood. (3) On the presence of α-hydroxy-acids in blood. Saccharic and mucic acids are formed by bacterial action in blood preserved *in vitro*; if the latter be inhibited, this oxidation process apparently does not occur.—F. G. **Cawston**: Variations in the shells of *Isidora africana* (Krauss) and closely allied species. It is difficult to divide this genus into species by the appearance of the shells, and the radulæ afford no better means of determining the species.—Sir Thomas **Muir**: Hadamard's approximation theorem since 1900.—Edith L. **Stephens**: A new sundew—*Drosera regia* (Stephens) from the Cape Province. This plant requires a moist and comparatively cool atmosphere such as is provided by the south-east cloud at the height of 3000 feet, where it flourishes. Possibly this may be connected with the very copious secretion of the tentacles, which is so viscid as to snare even grasshoppers and small beetles. It belongs to a section (Psycophila) hitherto unrepresented in South Africa. Its appearance is striking; a long peduncle, topped by a cluster of conspicuous pink flowers, being surrounded by linear leaves a foot or more in length.

WASHINGTON.

National Academy of Sciences (Proc Vol 12, No. 3, March 1926).—Carl **Barus**: Resonant acoustic and electric oscillations released by the relatively slow spring break.—William **Duane**: On the reflection by a crystal of its own characteristic radiation. Irregularities in the ionising current produced by the reflection of X-radiation (from a molybdenum target) by a crystal of potassium bromide have been observed which correspond to the bromine *K*-series lines. The increase, at any rate at the $K\alpha$ line of bromine (second order), seems to be due to an increase of fluorescent radiation at these points caused by slight imperfections of the crystal.—S. K. **Allison**: Note on the 'selective reflection' of X-rays by crystals of potassium bromide. The curve on which the preceding paper is based shows that a slight excess of radiation occurs only where reflection of the bromine $K\alpha$ line in the second order would be expected.—Robert S. **Mulliken**: (1) Systematic relations between electronic structure and band-spectrum structure in diatomic molecules (Part 1). The occurrence of features of band spectra can be explained on certain postulates. The first of these is that the electronic state of every molecule can be characterised by a term-designation associated with an electronic quantum number identical with Sommerfeld's atomic inner quantum number for the given term-type. (2) Part 2. The ZnH, CdH, and HgH molecules and their spectra. (3) The electronic states of the helium molecule.—Lee A. **DuBridge**: Variations in the photo-electric sensitivity of platinum. A platinum strip was heated for various periods in a vacuum and exposed to radiation from a quartz mercury arc lamp. For short or long heating periods, the photo-electric current decreases with temperature to a definite minimum which is not changed by prolonged heating or by further baking and out-gassing of the containing tube.—G. E. M. **Jauncey** and A. L. **Hughes**: Radiation and the disintegration and aggregation of atoms. A detailed statement of the arguments of a letter in NATURE of February 6, p. 193; $\lambda = 0{\cdot}0018$ Å.U. is corrected to $\lambda = 0{\cdot}00043$ Å.U.—Richard C. **Tolman** and Richard M. **Badger**: A new kind of test of the correspondence principle based on the prediction of the absolute intensities of spectral lines.—Roscoe G. **Dickinson** and Miles S. **Sherrill**: Formation of ozone by optically excited mercury vapour. Ozone is formed when oxygen at atmospheric pressure is passed over mercury and exposed to radiation from a water-cooled mercury lamp. Radiation of wavelength less than 2000 Å.U. was filtered out. Activated mercury atoms can give up energy to oxygen molecules as well as combining with it to form oxide.—George **Glockler**: Diffusion of electrons. The number of collisions which an electron makes in traversing a layer of gas, when the electron is not acted on by a field, is independent of its velocity and equal to $3a^2/2\lambda^2$, where a is the distance traversed and λ is the mean free path of the electron.—Lilian V. **Morgan**: Correlation between behaviour and shape of a chromosome.—Leonell C. **Strong**: The genetic basis of susceptibility to tissue transplants. Two relatively homozygous races of mice were used, in one of which a transplantable tumour showed progressive growth while the other race was resistant. The races were crossed and eventually synthetic races were selected which were susceptible and non-susceptible respectively, thus reproducing the original significant genetic constitution. Two factors seem to be concerned in producing susceptibility.—Joseph Miller **Thomas**: On various geometries giving a unified electric and gravitational theory. Einstein's new equations can be obtained by direct generalisation of his earlier equations of the gravitational field.—Sophia **Satina** and A. F. **Blakeslee**: (1) Studies on biochemical differences between (+) and (−) sexes in Mucors. (2) A preliminary report on the Manoilov reaction and other tests. Races of Mucor differ biochemically even when of the same sex; the (+) and (−) races show significant average biochemical differences, the (+) corresponding to the male of higher animals and the (−) to the female. (2) Biochemical differences between sexes in green plants. Average sex differences were found in respect to the Manoilov reaction, colour of leaf extract, presence of oxigenase, peroxigenase, and total acidity. (3) The Mucor parasite Parasitella in relation to sex. *Parasitella simplex* is a Mucor usually parasitic on other Mucors, when it forms galls. There may be some sex-relation between parasite and host.—Cecil D. **Murray**: The physiological principle of minimum work (1). The vascular system and the cost of blood volume. Calculations from the equations of flow through cylindrical tubes and the assumption of maximum economy of work, give values for the 'cost' of blood which accord well with the energy requirements of active tissues of the body. This 'cost' seems to be operative in determining conditions in the vascular system.—Curt P. **Richter**: The significance of changes in the electrical resistance of the body during sleep. Measurements were made of the resistance from hand to hand to an imperceptible electric current. During sleep the palm-to-palm resistance increases markedly, and this increase is some measure of the 'depth' of sleep, being very marked for heavy sleepers. On awakening gradually or suddenly, the resistance immediately becomes normal. Resistance measured between the backs of the hands increases a little where the sleep is tranquil and decreases with restless sleepers, possibly while dreaming. Patients in catatonic stupors resembling sleep do not show these characteristic changes of resistance.

Official Publications Received.

Svenska Linné-Sällskapets Årsskrift. Årgång 9, 1926. Pp. vi+154. (Uppsala.)

Union of South Africa. Report of the South African Museum for the Year ended 31st December 1925. Pp. ii+15+2 plates. (Cape Town.)

The Physical Society of London. Proceedings. Vol. 38, Part 3, April 15. Pp. 169-275. (London: Fleetway Press, Ltd.) 6s. net.

The Peabody Museum of Natural History. Bulletin 1, No. 1: Addresses delivered on the Occasion of the Dedication of the new Museum Building, 29 December 1925. Pp. 88. (New Haven, Conn.: Yale University.) 25 cents.

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 14, Part 3: On the Differences of the Physico-chemical Properties of the Protein, Oryzenin, as found in Glutinous and in Common Rice. By Tetsutaro Tadokoro, Yukihiko Nakamura and Shukichi Watanabe. Pp. 139-169. Vol. 15, Part 5: Studies on the Apple Rust caused by *Gymnosporangium Yamadae* Miyabe. By Tokuichi Fukushi. Pp. 269-307+plates 17-20. (Sapporo.)

Proceedings of the Cambridge Philosophical Society. Vol. 23, Part 2. Pp. 103-190. (Cambridge: At the University Press.) 7s. 6d. net.

Shirley Institute Memoirs. Vol. 4, 1925. Pp. vii+183+iv. (Didsbury, Manchester.)

Ingeniörsvetenskapsakademiens Handlingar Nr. 47: An Investigation of the Fatigue of Metals due to Locally Concentrated Stresses. By Ragnar Liljeblad. Pp. 17. (Stockholm.) 1.50 kr.

Seismological Report of the Apia Observatory, Samoa, 1923 July, to 1924 December. Pp. 9. (Apia.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 519: The Preparation of Levulose. By Richard F. Jackson, Clara Gillis Silsbee, Mary J. Proffitt. Pp. 585-617. (Washington, D.C.: Government Printing Office.) 10 cents.

British Non-Ferrous Metals Research Association. Sixth Annual Report for the Year ending December 31st 1925. Pp. 36. (Birmingham.)

League of Nations: Health Organisation. Public Health Services in Australia. By Dr. J. H. L. Cumpston and Dr. Frank McCallum. (C.H. 404.) Pp. 65. 1s. 6d. Cerebro-spinal Meningitis in Prussia in 1923 and 1924. Third (and Final) Report. By Prof. Dr. E. Seligmann. (C.H. 405.) Pp. 43. 1s. (Geneva: League of Nations; London: Constable and Co., Ltd.)

Proceedings of the United States National Museum. Vol. 67, Art. 9: Unusual Forms of Fossil Crinoids. By Frank Springer. (No. 2581.) Pp. 137+26 plates. Vol. 67, Art. 21: Studies on the Cyclostomatous Bryozoa. By Ferdinand Canu and Ray S. Bassler. (No. 2593.) Pp. 124+31 plates. Vol. 68, Art. 11: New Fossil Fresh-water Mollusks from Florida. By William B. Marshall. (No. 2612.) Pp. 4+1 plate. (Washington, D.C.: Government Printing Office.)

Smithsonian Institution: United States National Museum. Bulletin 132. Revision of the North American Moths of the Subfamilies Laspeyresiinae and Olethreutinae. By Carl Heinrich. Pp. v+216+76 plates. 75 cents. Bulletin 133: Observations on the Birds of Argentina, Paraguay, Uruguay and Chile. By Alexander Wetmore. Pp. iv+448+20 plates. 65 cents. (Washington, D.C.: Government Printing Office.)

Cornell University Agricultural Experiment Station. Bulletin 443: The Marketing of Cabbage. By E. G. Misner. Pp. 137. Bulletin 444: The Climate of New York State. By R. A. Mordoff. Pp. 88. Bulletin 445: A Preliminary Survey of Milk Marketing in New York. By L. J. Norton and Leland Spencer. Pp. 61. Bulletin 446: Index Numbers of Freight Rates and their Relation to Agricultural Prices and Production. By Harry S. Gabriel. Pp. 37. Bulletin 448: Root and Crown Injury of Apple Trees. By H. E. Thomas. Pp. 9. Memoir 96: Interspecific Transmission of Mosaic Diseases of Plants. By Karl Hermann Fernow. Pp. 34. (Ithaca, N.Y.)

Aeronautical Research Committee. Reports and Memoranda, No. 991 (Ae. 202): Full Scale Determination of the Lift and Drag of an Avro Type 504 K at large Angles of Incidence and Comparison with Model Results. By Dr. R. G. Harris and C. Howarth. (A.4.a. Full Scale Work, Aeroplanes-general 122—T. 2067.) Pp. 7+7 plates. (London: H.M. Stationery Office.) 9d. net.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 69: Seasonal Variation in Salinity of Nile Water at Rodah (Giza) with special reference to Alkaline Carbonates. By R. Aladjem. Pp. 11+1 plate. (Cairo: Government Publications Office.) 5 P.T.

United States Department of Agriculture. Department Circular 384: The Sterilization of American Foulbrood Combs. By A. P. Sturtevant. Pp. 20. 5 cents. Farmers' Bulletin No. 1374: Studies of the Pink Bollworm in Mexico. By W. Ohlendorf. Pp. 64. 15 cents. Farmers' Bulletin No. 1477: Preventing Damage by Lyctus Powderpost Beetles. By T. E. Snyder. Pp. ii+18. 5 cents. (Washington, D.C.: Government Printing Office.)

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 8, No. 3: Investigations on Indian Opium, No. 4: Further Experiments on the Influence of Manures on the Yield of Morphine Content of the Latex from the Opium Poppy. By Dr. Harold E. Annett and Har Dayal Singh. Pp. 23-51. (Calcutta: Government of India Central Publication Branch.) 8 annas; 10d.

Union of South Africa: Department of Agriculture. Science Bulletin No. 46 (Division of Chemistry Series No. 65): Co-operative Fertilizer Experiments with Potatoes. By Thos. D. Hall. Pp. 14. (Pretoria: Government Printing and Stationery Office.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Kitts-Nevis, 1924-25. Pp. iv+41. (Trinidad, B.W.I.) 6d.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Antigua, 1924. Pp. iv+19. (Trinidad, B.W.I.) 6d.

Proceedings of the Edinburgh Mathematical Society. Edited by Dr. T. M. MacRobert and Prof. H. W. Turnbull. Vol. 44 (Session 1925-26), Part 1. Pp. ii+66. (London: G. Bell and Sons, Ltd.) 5s. net.

The Rockefeller Institute for Medical Research. Organization and Equipment. Pp. 24+2 plates. (New York City.)

Diary of Societies.

MONDAY, May 24.

Royal Society of Edinburgh, at 4.30.—Dr. M. Wilson and Miss Cadman: The Life History and Cytology of Reticularia Lycoperdon: One of the Mycetozoa.—Dr. H. W. Davies: A Simple Arrangement for Administering Carbon Dioxide to a Patient to Stimulate Breathing (Demonstration).—Dr. C. C. Miller: The Slow Oxidation of Phosphorus Trioxide. Pt. 2—The Production of Phosphorus Tetroxide by direct Oxidation of Phosphorus Trioxide.—*To be read by title only*:—Dr. A. C. Aitken: On Bernoulli's Numerical Solution of Algebraic Equations.

TUESDAY, May 25.

Institution of Petroleum Technologists (at Royal Society of Arts), at 5.30.—E. Clark: Organic Theories of Oil Origin.

WEDNESDAY, May 26.

Radio Society of Great Britain (at Institution of Electrical Engineers), at 6.—Capt. P. P. Eckersley: Broadcast Reception (Lecture).

THURSDAY, May 27.

Linnean Society of London, at 3.—Anniversary.

Institute of Pathology and Research (St. Mary's Hospital), at 5.—Prof. D. P. D. Wilkie: The Functions of the Bile Passages in relation to their Pathology.

Royal Institution of Great Britain, at 5.15.—U. R. Evans: Corrosion, Tarnishing, and Tinting of Metals (2).

Royal Society of Medicine (General Meeting), at 5.30.—Sir Jagadis C. Bose: The Action of Alkaloids and Cobra Venom on the Pulse of the Plant and Animal (Lecture).

British Psychological Society (Joint Meeting of the General Society and the Æsthetics Section) (at Bedford College), at 5.30.—Prof. Alexander: The Creative Process in the Artist's Mind.

Institution of Electrical Engineers, at 6.—Annual General Meeting.

Royal Aeronautical Society, at 6.30.—F. W. Lanchester: Sustentation in Flight (Wilbur Wright Lecture).

Institute of Chemistry Students' Association (London) (Annual General Meeting), at 8.—Presidential Address.

Institution of Mining and Metallurgy (at Geological Society).

FRIDAY, May 28.

Royal Society of Medicine (Study of Disease in Children Section), at 5.—Annual General Meeting.

Physical Society of London (at Imperial College of Science), at 5.

Society of Chemical Industry (Chemical Engineering Group) (Annual General Meeting), at 6.

Society of Chemical Industry and Institute of Chemistry (Scottish Sections) (at St. Andrews University), at 6.30.—Principal Sir J. C. Irvine: Polysaccharides (Address).

Royal Society of Medicine (Epidemiology and State Medicine Section), at 8.—Annual General Meeting.

West London Medico-Chirurgical Society (at Kensington Town Hall), at 8.30.—Prof. G. Elliot Smith: Vision and Evolution (Cavendish Lecture).

Royal Institution of Great Britain, at 9.—Sir Almroth Wright: Aims and Methods of Therapeutic Research.

SATURDAY, May 29.

Royal Institution of Great Britain, at 3.—Prof. A. Moret: Une Révolution sociale en Égypte vers 2000 av. J.-C.

North of England Institute of Mining and Mechanical Engineers (Associates and Students' Section) (Annual General Meeting), at 3.—Discussion on Paper by J. G. Taylor on Coal and its Banded Constituents.—Prof. J. Poole: Notes on the Tour in Belgium and Germany (Address).

PUBLIC LECTURES.

THURSDAY, May 27.

University College, at 5.30.—Prof. Niels Bjerrum: The New Aspect of Strong Electrolytes. (Succeeding Lectures on May 28 and 31.)

CONFERENCES.

May 22 to 25.

Association of Teachers in Technical Institutions (at Regent Street Polytechnic).

May 23 to June 1.

Italian National Congress of Pure and Applied Chemistry (at Palermo).

May 24, etc.

International Geological Congress (at Madrid).

May 24 to 29.

International Ornithological Congress (at Copenhagen).

May 25.

International Society for the Protection of Childhood (at Rome).

SATURDAY, May 29.

Association of Women Science Teachers (at Northampton School for Girls), at 12.30.

INTERNATIONAL MEETING.

TUESDAY, May 25.

International Society for the Protection of Childhood (at Rome).

SATURDAY, MAY 29, 1926.

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Ethnographical Studies and Colonial Administration.

IN a recently published work by a resident in East Africa of many years' standing, it is stated that the native regards with profound mistrust all white men excepting only British officials and missionaries. This observation, perhaps a little too sweeping and perhaps too flattering to our vanity if assumed to be of universal application, lends support to the view, with which we have been made familiar since the British Empire became self-conscious, that members of the British race are pre-eminently successful as settlers and administrators in strange lands. In so far as this is borne out by the facts, it is in large part due to a certain ability to handle a backward people with a degree of sympathetic understanding. Although it is true that the British record in this matter has not been spotless in the past, and even now is not always above reproach, yet judged by results our methods may perhaps bear comparison, not entirely to their disadvantage, with those of other nationalities.

Lest such a comparison may appear invidious, it is possible to appeal for justification to facts which were forced on the attention of British officers in the former German colonies in Africa after the War. In the official reports, reference is frequently made to behaviour on the part of the natives which certainly seemed to indicate that their former rulers had inspired them with anything but confidence in the white man.

There is, however, less reason for diffidence on our part in instituting such a comparison now that in France, the power with a stake in tropical Africa second only to that of Britain, an appeal has been made to British methods to explain and justify action which has recently been taken by the University of Paris.

The pre-eminence of France in the study of prehistoric man and his handiwork has to a certain extent overshadowed the achievements of those of her men of science who have devoted themselves to other branches of anthropological investigation. To say this is not to ignore the claims of the distinguished human anatomists who have done so much to systematise the study of physical anthropology; or of the distinguished sociological group, with the late E. Durkheim at its head, which founded and carried on *L'Année Sociologique*, now happily revived after an intermission of some years owing to the War. Perhaps only those who follow specialist publications are aware of the extent to which ethnographical investigation has been carried on in the French colonies. Of the results, comparatively little has appeared in the more widely read publications devoted to the study of anthropology. A conspicuous example is the work which has appeared in the valuable and scholarly publications of the École d'Extrême Orient, dealing with the cultures and peoples of the French possessions in Further Asia. It ought, perhaps, to be unnecessary to emphasise the value of much of the work which has been done in Madagascar and the colonies of North and West Africa.

On more than one occasion in these columns, stress has been laid on the practical value of anthropological training in the administration of the affairs of backward races, or, to use the more general term, of peoples of non-European culture. It has been of interest to those who take this view to note that in the courses of lectures on ethnology and other departments of anthropology which were advertised at the opening of last winter's session of the University of Paris, there was a distinct bias in the direction of the possible practical application of the instruction to be given. Even courses of a general character in the study of religion and social anthropology frequently had special reference to the native races of some or all of the French colonial possessions. The study of Moslem custom and religion was naturally capable of more directly utilitarian treatment; while a large number of courses in linguistics covered many of the more important native languages under French jurisdiction.

A more significant development, however, is the foundation within the University of Paris of an Institute of Ethnology. The object of the Institute is, in the first place, to create a body of professional ethnologists and to give to any residents or intending residents in the French colonies who have an inclination for linguistic or ethnological studies, such instruction as will enable them to carry on these studies intelligently and in accordance with methods which will render the material collected of scientific and practical value. Secondly, to direct attention to recently discovered facts or newly developed methods with the view of their verification, and the testing in the field of any hypothesis under discussion. Thirdly, to publish ethnographical works which, owing either to their length or the amount of illustration they require, cannot be published in the usual periodicals. Fourthly, in conjunction with the colonial authorities, to send expeditions into the field and not to leave to foreigners the exploitation of the ethnography of the French colonies, as has happened in the past.

The idea of such an Institute was first put forward by M. Marcel Mauss in 1914; but its realisation has only recently been attained, the project having been revived in 1924. As a teaching body the Institute will in no way conflict with any existing interests. On the contrary, its primary function will be to act as a co-ordinating body for the courses already provided, or to be provided, at the University, the Collège de France, the Museum, the École des Hautes Études, the École Coloniale, and the École des Langues Orientales Vivantes. It will provide, in addition, in courses such as cannot be obtained elsewhere, a small number of lessons in technical matters with the view of giving an orientation to the future ethnologist. The Institute will grant a diploma in anthropology and, if or when the necessary ministerial permission has been obtained, a certificate of Licencié ès Lettres.

It is not without interest to note that Prof. Lévy-Bruhl, in an account of the Institut d'Ethnologie and its organisation and objects, which appears in the *Revue d'Ethnographie et des Traditions Populaires*, 4me trimestre, 1925, Nos. 23-24, indicates to what an extent the founders have been influenced by British methods in defining the scope and methods of the Institut. He opens with a reference of some length to Capt. Rattray's book on Ashanti, pointing to the incident of the 'Golden Stool' there related as an example of the way in which a serious conflict with the natives, and very possibly a punitive expedition, were averted by the advice based on expert knowledge which the newly constituted anthropological service was able to place at the disposal of the administration. Had it not been for the official anthropologist's knowledge of native customs and ways of thought, action in connexion with the Stool which it had been decided to take, without thought of its possible effect on the religious susceptibilities of the native in view of the sacred character of the Stool, would almost certainly have caused a serious uprising. Prof. Lévy-Bruhl goes on to express the hope that a similar anthropological service may one day be instituted in the French colonies. It will then be the aim of the Institut d'Ethnologie to turn out officers competent to man it, not necessarily highly trained ethnologists, but men with a sufficient knowledge of anthropological method to enable them to collect material of both scientific value and practical utility. He pertinently adds that in the study of the resources of the French colonies which is necessarily a preceding condition of their full development, the greatest asset of all, the native population, should not be overlooked.

However flattered we may feel at the compliment implied in Prof. Lévy-Bruhl's reference to the work of Capt. Rattray and his department, British anthropologists have still to regret that the principle that all administrative officials in British dependencies with backward peoples under their jurisdiction should be trained in anthropological methods is an ideal which has yet to be officially adopted in practice. An argument which is applicable to the case of the French colonies should, it is permissible to say, apply with immensely greater cogency to that of the British Empire.

Man at Great Altitudes.

The Respiratory Function of the Blood. By Joseph Barcroft. Part 1: *Lessons from High Altitudes.* Pp. x+207. (Cambridge: At the University Press, 1925.) 12*s.* 6*d.* net.

WHOEVER reads this book—and every physiologist who deals at all with the hæmato-respiratory functions must read it—will gain one certain result: he will conceive a sincere liking for the author, as the ideal companion under low barometric pressure. In a style intimate, as between comrades in adventure, Prof. Barcroft here sets forth his experiences in his various invasions of the regions of low oxygen, the Peak of Teneriffe, the Capanna Margherita on the summit of Monte Rosa, Cerro de Pasco in the Andes, and last but not least the glass chamber in his laboratory where for six days he breathed the oxygen down, and himself thus virtually up, to the physiological equivalent of an altitude which proved too much of a strain even for his bold and cheerful spirit.

Prof. Barcroft reminds us that the modern sport of mountaineering originated in such essentially scientific expeditions to the upper regions as those of de Saussure on Mont Blanc. It is quite proper, therefore, that the scientific treatment of the physiological effects of low oxygen, mountain sickness, and acclimatisation should retain something of the zest of a noble sport. In this field the investigator is himself the subject observed, and in his own person suffers discomfort and overcomes hardships as great as any explorer of a new country. Yet it is also in this field that physiology has most nearly emulated the precision of physics and chemistry. It requires literary art to bring out the sporting aspects of oxy-hæmoglobin dissociation curves. Prof. Barcroft imparts 'human interest' (to use the journalistic term) even to the gas laws.

As it happens, although mountaineering is not a competitive sport, the physiology of altitude is just now almost as competitive as football or rowing between two of the universities of England. It was shown by Paul Bert in France in the last century by means of a low-pressure chamber, and by the late Prof. Zuntz of Berlin by his expeditions to the Alps, that the one essential factor in the decrease of barometric pressure at great altitudes is the lower partial pressure of oxygen in the lungs and in the blood. The condition induced is essentially asphyxia.

During the first decade of this century, Haldane and his co-workers at Oxford carried out experiments which were so fundamental and so illuminating that they may be said to have created the physiology of respiration. To follow up the principles of vital regulation thus revealed, the next step was the study of the adjustment which respiration may make to the decreased oxygen pressure at high altitudes. Accordingly, Haldane and Douglas from Oxford, accompanied by Henderson and Schneider of Yale, spent five weeks during the summer of 1911 on the summit of Pike's Peak, Colorado, altitude 14,100 feet. Their observations were supplemented by Miss M. P. FitzGerald, who determined the alveolar carbon dioxide and the hæmoglobin of people resident at various altitudes between sea-level and 11,000 feet. The fundamental principle was thus established that the adjustment of respiration in states of complete acclimatisation is strictly quantitative. The basic controlling factor is the partial pressure of oxygen in the lungs. To this factor (*a*), the alveolar carbon dioxide (*b*) and the blood alkali (*c*) come gradually at every altitude into the relation $a:b:c=100:40:60$ (for example, 50:20:30 at about 17,000 feet, bar. 390 mm.); and the volume of breathing during rest is the reciprocal of the alveolar carbon dioxide.

In addition to this law, Haldane postulated an active secretion of oxygen by the tissues of the lungs, so as to raise the pressure of oxygen in the blood above that in the air in the lungs: a process analogous to that by which the kidney may produce urine of higher concentration in respect to salts than in the blood from which the salts are drawn.

At this point Barcroft takes up the story; and the book before us is in the main an account of the investigations of the Cambridge-Harvard expedition to the Andes which he organised and led. On the basis of the results obtained by that expedition, Barcroft accepts in the main the first part of the conclusions of the Pike's Peak expedition; but he rejects now absolutely the hypothesis of oxygen secretion in the lungs. It must, indeed, be admitted that the direct determinations of the pressure of oxygen in the arterial blood in relation to that in the air of the lungs, which he and his co-workers achieved, afford strong evidence that the former never exceeds, indeed never quite equals, the latter. Thus the passage of oxygen from the atmosphere into the blood must be dependent, according to the view of Prof. Barcroft and his co-workers, wholly upon the physical process of diffusion. The adjustments constituting acclimatisation do not then include oxygen secretion.

How great a problem is thus presented to physiology is evident from the fact which Prof. Barcroft points out that healthy men who go in a day, even by railway and with no exertion in comfortable, well-heated cars, from sea-level up to 14,000 feet in the Andes, are rendered acutely ill. Men who ascend direct from sea-level to 23,000 feet in a balloon lose consciousness and die. Yet a large population in the Andes and Tibet spend their entire lives at 14,000 or 15,000 feet, and the members of the two expeditions above referred to were quite comfortable and well when acclimatised at Cerro de Pasco and on Pike's Peak. Furthermore, the members of the Mount Everest expeditions became acclimatised to 23,000 feet, and in some cases ascended even to 26,000 feet without mountain sickness, as is described in an appendix in this book by Major R. W. G. Hingston, Medical Officer to the Everest expedition of 1924.

The utmost value attaches, therefore, to Prof. Barcroft's observations and discussions bearing upon different aspects of the problem of accounting for so extraordinary a power of adjustment in the living organism. Prof. Barcroft would himself be the first to recognise that if oxygen secretion is ruled out (and Dr. Haldane is still to be heard in reply at the meeting of the British Association at Oxford next August) the problem of acclimatisation stands out only the more imperatively. Thus, if the reviewer may be allowed to instance facts which the conception here presented seems scarcely as yet adequate to cover in detail, attention may be called to the rapidity with which a person acutely mountain-sick may develop a comfortable degree of acclimatisation. Such cases of rapid acclimatisation were easily explained on the theory of oxygen secretion. They still require much study to show how they are possible as results of the comparatively slowly developing changes in the blood. Indeed, the shift of the oxy-hæmoglobin dissociation curve to the left which Prof Barcroft now postulates was not found in any previous investigation, either by the Pike's Peak expedition (using Barcroft's method) or by himself at Teneriffe. It affords one of the strongest grounds for seconding Prof. Barcroft's expressed hope that others may carry further the study of altitude at Cerro and on Pike's Peak.

Attention may also be directed to the proven efficiency of inhalation of dilute carbon dioxide in overcoming the ill effects (which are essentially mountain sickness) following carbon monoxide asphyxia, and following anæsthesia. Such beneficial effects are presumably due to an adjustment of the blood of the same general character as that which Prof. Barcroft postulates in acclimatisation; but in this case probably the shift is to the right.

It is especially to be hoped that the unique opportunities of observing acclimatisation between 15,000 and 25,000 feet afforded by expeditions to Mount Everest will hereafter be utilised to the full. In future expeditions to Tibet it should be possible to combine this object without impairing the chances of attainment to the highest point in the world. For science the value of this accessory service would certainly equal the primary object of expeditions to Mount Everest.

In closing, a few words may be permitted on the general importance of the problem of asphyxia to the solution of which Barcroft and Haldane in their friendly controversy are making fundamental contributions.

The most universal and characteristic process of life lies in the exchange of oxygen, combustion in living cells or, as physiology terms it, respiration. When we understand asphyxia and the adjustments which the living body makes to combat it, we shall have solved a problem which is the reciprocal of that of the nature of life. We may fairly hope that, at least to a considerable extent, mere inversion of the terms in which the solution of the problem of asphyxia will be stated, will afford a solution of the inner nature of respiration, and thus far of life itself.

YANDELL HENDERSON

The Geology of West Lothian.

The Rocks of West Lothian: an Account of the Geological and Mining History of the West Lothian District. By Henry M. Cadell. Pp. xvi + 390 + 32 plates + 2 maps. (Edinburgh and London: Oliver and Boyd, 1925.) 18*s.* net.

THE county of West Lothian is of exceptional interest in Scottish geology, as it forms the connecting link between the two ends of the Midland Valley, and affords the most trustworthy evidence for the correlation of the dissimilar Carboniferous sequences in the western and eastern basins. The county is also of interest as the seat of the Scottish oil shale industry.

The geological and physiographic history of the county has been summarised by Mr. H. M. Cadell in an interesting and beautifully illustrated volume. Mr. Cadell knows the county intimately; he understands its relations to the rest of Scotland from knowledge gained during his service on the Scottish Geological Survey; and he brings to the interpretation of its rocks observations made during world-wide travels. Many of the illustrations are drawn from his foreign experiences, such as below a reproduction of von Humboldt's famous view of Jorullo in 1803, his own sketch taken from the same point of view in 1906. Much of the information in the volume has been previously published in technical journals, but it has been re-written in a simpler and more popular form.

The book is most concerned with the Scottish Carboniferous system; it gives an excellent account of the geology and economics of oil shale, and of some of the associated rocks such as the Houston marls, which the author shows are not of volcanic origin. He records the result of the bore at West Calder, 4000 ft. deep, put down in the search for mineral oil; instead of finding oil, it passed through an unexpected thickening of the volcanic rocks below the Burdiehouse limestone. The chapters on the Lower Carboniferous rocks describe their successive limestones and volcanic phenomena, which in this district are exceptionally well displayed, partly in surface outcrops, and partly in the evidence as to the deep-seated structure of some ancient volcanoes revealed by bores put down during mining prospecting. During the Carboniferous, according to the author, the country was broken across by an east-to-west rift valley, between the Ochiltree fault on the north and the Calder and Middleton Hall faults on the south; he illustrates this valley by one of his graphic reconstructions of the scenery, due to his combination of geological insight and artistic skill.

Mr. Cadell was one of the first Scottish geologists to recognise the importance and significance of the buried river channels that lie deep below the present sea-level; he brings the knowledge of those in West Lothian up-to-date in chapters dealing with the development of the present topography during the Kainozoic era, of which the only local evidence is physiographic.

The last three chapters are devoted to the history of mining in the county from that at Carriden about 1165 by the monks of Holyrood; he describes the condition of coal mining in the seventeenth century during the wars of the Commonwealth, gives an account of the early Scottish salt industry, and tells the story of the Hilderston silver mine, which was worked early in the seventeenth century and was unsuccessfully re-opened in 1873 and 1896. The author, owing to his descent from the founder of the Carron Co., has been able to draw on unpublished records in his interesting account of the mining and iron industry of the Bo'ness district since 1760.

Nematode Parasites of Vertebrates.

The Nematode Parasites of Vertebrates. By Prof. Warrington Yorke and Dr. P. A. Maplestone. Pp. xi+536. (London: J. and A. Churchill, 1926.) 36s. net.

THE outstanding spirit of the early study of helminthology was the search for knowledge for its own sake; whereas the motive underlying the activities of workers of more recent years has been, partly unconsciously perhaps, its potentiality for human and animal welfare. The literary output on the subject of the structure and relationships of the Nematoda during the last hundred years was enormous, and the position would doubtless have been chaotic had not Diesing, in 1866, summarised the knowledge of that time in his "Revision der Nematoden," and Stiles and Hassall, in 1919, provided the materials for a similar revision in the invaluable subject-index on the roundworms, in their "Index Catalogue of Medical and Veterinary Zoology." During the past ten years the labours of Railliet, Skrjabin, and Travassos have resulted in a classification of the parasitic nematodes which has met with considerable acceptance, though of course, in points of detail, there remains room for adjustment. The volume issued by Yorke and Maplestone is therefore to be welcomed as marking the present position of the classification of the Nematoda in the same significant way as did that of Diesing half a century ago.

The authors have handled the vast mass of material in a masterly manner. Accepting Railliet's classification in the main, they have provided a series of definitions and keys which should enable those acquainted with the structure of the Nematoda to place many, if not all, of the known species in their proper genera. Each genus is illustrated and defined, the definition being based largely upon the type species; other species which in the authors' view can be reasonably allocated to the genus are listed alphabetically.

As generic definitions based too closely upon the type frequently contain characters of specific value only, this method is likely to entrap the unwary. Moreover, those who prefer to rely upon text-books rather than consult the original publications, should note that many of the older and probably legitimate species have been omitted, and there is a distinct danger that these may be recorded again as new species. It is perhaps regrettable that some provision, such as the compromise recently suggested by Stiles, has not been adopted whereby collective group names, *e.g.* Fusaria, Sclerostoma, and so on, would have been given some taxonomic place to species which, although probably valid, have not yet been sufficiently fully investigated to admit them to modern and more restricted genera.

With each species the 'type host' in which it has been found is listed, but no indication is given of the almost equally important 'type locality,' although the subject of geographical distribution is one which is likely to interest many of those who turn to this work for information. The same may be said of intermediate hosts. In these days, when the bionomics of animals is attracting more and more attention, the omission of all reference to the life-history in a book with such a comprehensive title is, to say the least, unfortunate.

In the course of their revision the authors have found it necessary to create a number of new genera, many of which are based on new species, of which brief descriptions are given in the form of footnotes.

More than three hundred genera are illustrated in the text, and in most cases the type species has been used. Many of these are original, but the goodwill of other workers has been relied on for this purpose to a surprising degree.

In spite of these criticisms, the authors are to be congratulated not only on having produced a work which is likely to become a standard book of reference, but on having also made a definite contribution to the classification of the order Eunematoda.

The Composition of Milk.

Variations in the Composition of Milk: a Study of the Results of Analysis of Six Hundred and Seventy-six Samples of Milk (each Sample being the Milk of one Cow) from Cows of various Breeds throughout Scotland in 1921–22. By Dr. J. F. Tocher. Pp. 195. (Edinburgh and London: H.M. Stationery Office, 1925.) 21*s.* net.

THE Inter-departmental Committee appointed to report on the regulations, etc., governing the sale of milk in Scotland arranged for a large number of samples of milk taken at random from individual cows to be analysed. No particular breed was selected, nor was any account paid to the period of lactation, feeding, age of animal, etc., the only consideration being to ensure proper and thorough milking and the taking of a representative sample. In all, 676 samples of milk were dealt with, the samples being both from morning and evening milkings, with a small proportion of midday samples (the latter, however, not included in the statistical analysis). The examination of the samples covered the usual determinations of specific gravity, fat, solids not fat, and in addition the estimation of nitrogen, lactose, ash, refractive index and freezing-point.

The report which Dr. Tocher has drawn up gives a very exhaustive account of the manner in which the inquiry was conducted, the results of the determinations, the statistical analyses of the results and the conclusions which may be drawn from them.

Whilst the object of the inquiry was to collect data upon which legislation could be based, the information which has been gained is of considerable scientific interest, and some important facts concerning the composition of milk and the extent to which the constituents vary in the case of individual cows has been brought to light. The milk of single cows is shown to vary widely, in the case of butter fat from 1·7 per cent. to 7·5 per cent., whilst the solids not fat may be from 6·9 per cent. to 10·6 per cent. In the case of composite samples there were found to be wide differences according to the number of cows from which the milk sample was taken. Thus herds of five cows fell below the present standard for solids not fat (8·5 per cent.) in the proportion of six groups out of a hundred, whilst larger herds of twenty cows only fell below the standard in one group out of a thousand.

On the practical side of the subject, Dr. Tocher advocates that milk should be supplied from a large number of cows so as to reduce the variations; that good cows should be selected and that the inheritance of butter-fat yield should be completely studied. Some other matters of interest in the report are the lactose content and freezing-point of milk, the influence of the lactation period and the effect which this may have upon the interpretation of the results of feeding trials.

Our Bookshelf.

Handbuch der Arbeitsmethoden in der anorganischen Chemie. Gegründet von Arthur Stähler. Fortgeführt von Prof. Erich Tiede und Friedrich Richter. Zweiter Band: *Physikalische und chemische Operationen.* Zweite Hälfte: *Physikalische und chemische Operationen besonderer Art.* Herausgegeben von Prof. Erich Tiede und Friedrich Richter. Pp. x+655+1648. 54 gold marks. Vierter Band: *Ausgewählte Kapitel der präparativen Chemie.* Zweite Hälfte. Pp. x+315-572. 14·50 gold marks. (Berlin und Leipzig: Walter de Gruyter und Co., 1925 and 1926.)

THE special operations described in the second part of the second volume of this work include micro-chemical methods, membrane-filtration, electrometric analysis and electrolytic purification, decomposition with a silent electric discharge and in the arc, the use of radio-elements as indicators, identification of crystals and X-ray analysis, the use of high vacua and of high pressures, mass-spectrography, the use of liquid ammonia, sulphur dioxide, hydrogen chloride and hydrogen sulphide as solvents, and the general operations of photochemistry. The technique of these diverse operations has been described by fifteen authors, in a volume of about 1000 pages. It will form a most valuable work of reference for those who may have occasion from time to time to make use of one or other of the special methods with which it deals.

The first part of the fourth volume had already appeared when the present editors took charge of the "Handbuch." They did not regard it as necessary to carry to completion the original plan for the volume on preparative chemistry, but have concluded their work by adding to Part 1 of vol. 4 an abbreviated Part 2, dealing with thermite-reactions, phosphorescent materials, mineral synthesis and the growing of crystals. They have also included a very interesting catalogue of some hundreds of substances which can be prepared in a state of great purity (*e.g.*, as required for determinations of atomic weight), with references to the original papers in which the methods of preparation of these pure elements and compounds are described.

The Engineer and the Prevention of Malaria. By Henry Home. Pp. x+176+14 plates. (London: Chapman and Hall, Ltd., 1926.) 13*s.* 6*d.* net.

The object of this book, as mentioned by the author in the introductory note, is to help engineers engaged on anti-malarial works to obtain the necessary information without reference to numerous publications on public health, entomology, and parasitology which is otherwise essential. It is furthermore believed that medical officers will find material of value within its pages.

The book deals with the various engineering problems which so frequently arise in malaria prevention in a clear and concise manner. There are fourteen plates and numerous text figures which contribute to the value of the work. The first three chapters are devoted to the economic aspect of the disease, the malarial mosquito, and to anti-malarial schemes. The eight following chapters deal with the varied aspects of lowland drainage, hill drainage, details of construction, oiling, larvicides, vegetation, natural enemies, the question of housing, and possible biological methods of control.

There are four appendices, the first of which, by Lieut.-Colonel MacArthur, deals with mosquito netting from the point of view of the right determination of the apertures and the gauge of wire or the size of cotton thread used by the manufacturers.; Dr. P. A. Buxton contributes the next two appendices dealing with applied entomology as regards anophelines and the house fly. The final appendix contains an account of the hydrogen-ion concentration of waters and methods of estimation.

The engineer and the sanitarian are, or at least should be, frequently associated in endeavours to combat disease, and this is especially the case in anti-malarial schemes. To formulate a successful campaign on sound practical lines demands a close co-operation between the two services. In this little book both should find much of common interest, and its study will undoubtedly tend to foster that spirit of co-operation with and sympathy in the work of the two which is essential in so many of the efforts directed to the control of disease.

G. E. F. STAMMERS.

Rothamsted Experimental Station Library. Catalogue of the Printed Books on Agriculture published between 1471 and 1840; with Notes on the Authors by Mary S. Aslin. Pp. 331+22 plates. (Harpenden, Herts: Rothamsted Experimental Station, 1926.) Paper, 10*s.*; cloth, 12*s.*

Not the least notable feature of the Rothamsted Experimental Station is the library, containing as it does probably the most complete collection in existence of ancient and modern books (in all languages) on agriculture. The number of ancient books, in particular, is remarkable, including, it may be noted, copies of such treasures as Crescentius' "Liber ruralium commodorum," the first printed book on agriculture. Of this the library possesses a fine illuminated folio, bearing the insignia of Sigismund II. of Poland, and a unique early edition of Fitzherbert (*circa* 1523).

As the director, Sir John Russell, points out, the dates 1471 and 1840 are both significant in relation to the history of agriculture; the first marks the appearance of Crescentius, and the latter the definite break with empiricism which followed the foundation of the Rothamsted Station by Lawes. The catalogue, therefore (relating to 1500 books published between these dates), may be said to record the empirical stage of agriculture, and it speaks much for the enterprise and, may we add, the culture of the governors of Rothamsted and their director, that such a collection—largely of bibliographic interest—should have been added to the institution. Their interests in the art, which it is their mission to inspire with science, are conceivably more limited, but, as the director, in the words of Comte, aptly says: "No idea can be properly understood apart from its history."

Volumetric Iodate Methods. By Dr. George S. Jamieson. (New York: The Chemical Catalog Co., Inc., 1926.) 2 dollars.

The "iodate method," first proposed by L. W. Andrews in 1903, depends on the formation of iodine monochloride, and the disappearance of the iodine colour imparted to an immiscible solvent such as chloroform or carbon tetrachloride. Since the last traces of free iodine are collected in a small volume of immiscible solvent, the sharpness of the end-point is remarkable; and when a titration has been completed, there is no return of the iodine-colour even after keeping the solutions for a day. These factors, together with the great stability of the solutions of potassium iodate and the absence of interference by many kinds of organic matter, make the use of this method very advantageous in many forms of analysis. The author has therefore put together a description of a dozen different determinations (*e.g.* of Sb, Cu, Hg, Mo, Sn, Mn, N_2H_4, H_2O_2, PbO_2, etc.) in which the method can be employed with advantage. He has further increased the value of the book by giving details of the application of the method to the analysis of arsenic and copper in insecticides, of antimony, copper and tin in alloys, etc. The book should be of considerable value in giving publicity to a new and valuable method of analysis, as well as in providing precise directions for applying it.

Wellenlangenmessungen des Lichtes im sichtbaren und unsichtbaren Spektralbereich. Von Prof. Dr. Paul Eversheim. (Sammlung Vieweg, Heft 82.) Pp. v+111. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1926.) 7 gold marks.

The object of this book is to give a concise survey of the present state of our knowledge concerning the exact determination of standard wave-lengths. The author first gives a short general description of early measurements, together with Rowland's normal system, and refers to the necessity for its revision. He then deals with the more recent methods of determination, briefly referring to Millikan's work, and considering in detail the measurements of Benoît, Fabry and Perot. Succeeding chapters discuss the establishment of international standard wave-lengths, and many tables of standard lines in the visible region are given, attention being paid to the results of individual workers in order to indicate the accuracy of the standard data.

The ultra-violet and infra-red portions of the spectrum are treated in separate sections, due reference being made to the work of Lyman and Millikan. In the final chapter on X-rays, the work of the Braggs, of

Siegbahn and of others is described, and two clear diagrams of modern X-ray tubes for spectroscopic purposes are given.

The book may be thoroughly recommended to all interested in the matters with which it deals.

Adventures of Exploration. Book 4: *Africa.* By Sir John Scott Keltie and Samuel Carter Gilmour. Pp. iv + 180. (London: George Philip and Son, Ltd.; Liverpool: Philip, Son and Nephew, Ltd.; n.d.) 2*s.*

THIS volume is the most recently published of a series of six supplementary readers designed to quicken interest in geography by stories of adventurous travel. They do not claim to give a coherent history of exploration, but serve to direct attention to the great steps and prominent names in the story of discovery. In this respect they form valuable supplements to the orthodox geographical text-book. After a general chapter on early voyages the story begins with Bruce at the Blue Nile, moves to Mungo Park and the Niger, and after a chapter on the seekers for Timbuktu, takes the reader to the great lakes, the Nile sources, with chapters on the work of Burton, Speke, Baker, Thomson, Livingstone, Stanley, and others, and finishes with some of Selous' adventures and Hassenein Bey's recent journey. The stories are admirably told, and well illustrated with maps and pictures. The series deserves to be widely used. R. N. R. B.

Macmillan's Secondary School Atlas. With an Introduction by T. Alford Smith. Pp. iv + 64 + 8. (London: Macmillan and Co., Ltd., 1926.) 5*s.*

THE 64 pages of coloured maps in this atlas include physical and political maps of every part of the world, with enlarged maps of Europe and the more important parts of other continents. There are also January and July temperature maps and annual rainfall maps of all continents and the British Isles, geological maps of the British Isles and Europe, and a number of distributional maps of the world. The physical maps are particularly good, and not overcrowded with names. On all maps the projection is given. Although the scales vary a good deal, an attempt has been made to use simple multiples of the scales of the maps of Great Britain. An index of some two thousand names gives reference by latitude and longitude. The world-pressure maps would be improved by southward extension to show the Antarctic high-pressure area, and in the current and vegetation maps some revision is required on the coasts of Greenland. Murmansk, and not Alexandrovsk, is the terminus of the Murman railway.

The Story of Minerals. By Herbert P. Whitlock. (The American Museum of Natural History, Handbook Series No. 12.) Pp. 144. (New York: American Museum of Natural History, 1925.) n.p.

IN this book the author has aimed at a popular exposition of the elements of mineralogy, his declared intention being "to answer questions rather than to rehearse facts." In preparing it, he has taken advantage of his experience as Curator of Mineralogy in the American Museum of Natural History, and has fashioned the book to answer questions usually put by visitors to the Museum. About a third of the book is given to the principles of mineralogy, including chapters on "Nature's mathematics" (crystallography), "the mimicry of minerals," "water as a maker of minerals," and "change and decay in minerals." The remaining chapters describe some of the commoner minerals and groups of minerals. The book is very well illustrated, and should prove interesting as well as useful to those numerous visitors to the Museum who have not previously studied the science of mineralogy.

Introduction to the Study of Organic Chemistry: a Theoretical and Practical Text-book for Students in the Universities and Technical Schools. By Dr. John Wade. Revised by Dr. Henry Stephen. New and enlarged edition, with an Appendix containing Supplementary Practical Detail, forming with the text an Illustrative Laboratory Course. Pp. xx + 646. (London: George Allen and Unwin, Ltd., 1925.) 8*s.* 6*d.* net.

WADE'S "Organic Chemistry" is a book which has enjoyed a deserved popularity for some years. It is therefore only necessary to say that the new edition appears to have been carefully prepared, and that the appendix of laboratory experiments, occupying 65 pages, makes the volume a self-contained guide for students preparing for honours degrees. Dr. Stephen has added a new chapter on derivatives of pyrone, chromone and xanthone, and some new matter at the ends of various chapters. The price of the book brings it within the reach of students, and it may be warmly commended.

Gems and Gem Materials. By Prof. E. H. Kraus and Dr. E. F. Holden. Pp. vii + 222. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 15*s.* net.

THIS is a well-illustrated account of gem minerals, in two parts. The authors remark in a brief introduction that the study of gem minerals has been named "gemmology," but it is a great relief to have their assurance that this term is not widely used. Part 1 (pp. 9-104) deals with the general properties of minerals, including chapters on the genesis, cutting and polishing, naming and manufacture of gem stones. Part 2 (pp. 107-213) gives descriptions of the various minerals used as gems, and includes numerous tables in which gem minerals are classified according to their properties. The last of these tables gives a summary of the properties of gem minerals described in the text, the arrangement of the minerals being alphabetical. The book concludes with a useful index.

Le mouvement scientifique contemporain en France. 3: *Les sciences physico-chimiques*; 4: *les sciences mathématiques.* Par Dr. Georges Matisse. (Collection Payot.) Pp. 320. (Paris: Libr. Payot, 1925.) 10 francs.

THIS volume constitutes a small guide-book which indicates the main contributions of French chemists, mathematicians, and physicists to modern scientific knowledge. Since the work of about thirty scientific workers is summarised, that of any individual worker is only outlined in a very brief manner.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Magnetic Properties of Single Crystals of Iron.

FORMERLY the preparation of single crystals of iron has been made by Goldschmidt's method, by which means crystals ranging from one to two centimetres in linear dimensions can be obtained, but the production of larger crystals by the same method is almost impossible In 1924, however, Prof. C A. Edwards obtained large crystals of iron by using Prof. Carpenter's method of preparing single crystals of aluminium, and thus opened to us an important route for the investigation of the true nature of the metal. Hitherto we have been able to measure only the mean of the properties differing in various orientations of the crystal; but we are now in a position to study the property of an individual crystal in different directions relative to its orientation

Since the beginning of last year the present writers have used this method and obtained crystals of iron, for which the magnetic properties have been measured. The first communication of ours dealing with this investigation was published at the autumn meeting of the Denki Gakkai, Tokyo (Institute of Electrical Engineering), on Oct. 24, 1925 The present note contains the results of the investigations we have made during last year

The magnetisation was measured with a rod of a single crystal of iron of the dimensions, 68 1 × 2 4 × 1 81 mm³, the axis of the rod being inclined at angles of 21° 10′ and 70° 10′ to the tetragonal axis of the crystal The ballistic method was used for the measurement of magnetisation. The curve of magnetisation plotted against the effective field is given in Fig. 1

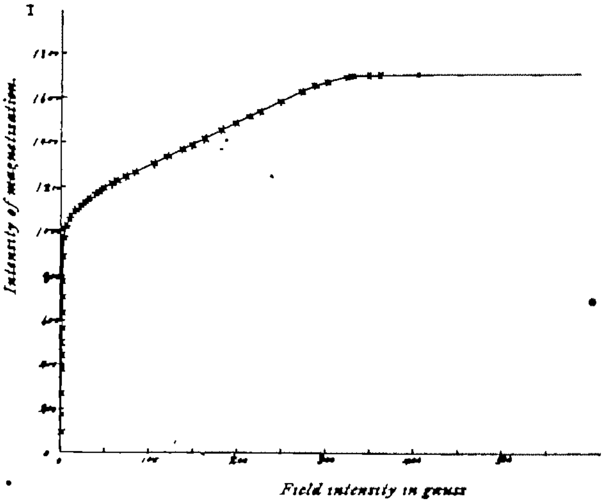

FIG 1.—Magnetisation curve of a single crystal of iron.

The characteristic features of the magnetisation curve are as follows:

(*a*) The curve is almost straight up to an intensity of magnetisation of 1000 c g s. units

(*b*) Then the curve shows two sharp breaks or bendings.

(*c*) The saturation of magnetisation is much more easily attained than in the case of polycrystals, its value being 1710.

The hysteresis loss of a single crystal of iron is very small, amounting only to one-tenth of that of ordinary sheet iron containing silicon It increases very rapidly with the numbers of grains or crystals in a specimen, as is shown in Fig 2. It is therefore to be concluded that the hysteresis is considerably affected by an irregular distribution of molecular magnets at the grain boundaries

The initial and maximum permeabilities also decrease with the number of grains. The following table contains the numerical results of our observations in this direction:

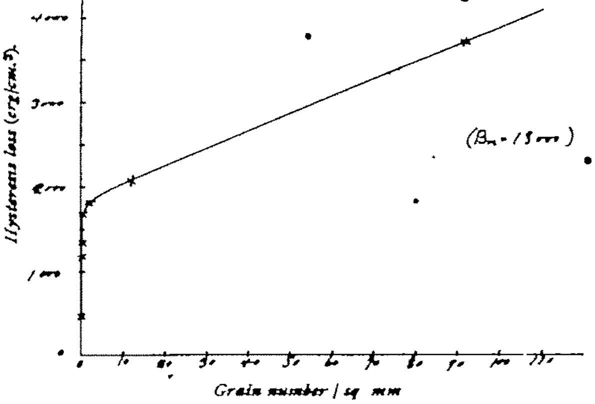

FIG 2.—Curve showing the relation of hysteresis loss to number of grains or crystals in the specimens

Grain Number per mm².	Initial Permeability	Max. Permeability	Hysteresis Loss.	Demagnetising Force.
			Ergs.	Gauss
92	600	3400	3730	0·604
12·1	900	3740	2070	0·325
1·9	980	3700	1840	0 273
0 15	1000	. .	1325	0·168
0·092	1500	4430	1170	0·147
0·0067	1700	4300	460	0·063

Five rods of single crystals and of dimensions 2 × 2 × 40 mm³, of which three had their axes approximately lying in plane (100) and other two in plane (110), were next prepared; their axes had the following orientations with respect to the principal axis of the crystals

Specimen.	Orientation	
No. 1	14°	
„ 2	25°	nearly in plane (100),
„ 3	33°	
„ 4	27°	nearly in plane (110).
„ 5	41°	

With these rods the magnetic expansion was measured up to an effective field of 500 gauss by the method usually employed in our institute (*Sci. Rep*, 9, 1920). The results of measurement are graphically given in Fig 3 and may be summarised in the following terms:

1. The magnetic expansion of single crystals of iron is generally very large as compared with that observable in ordinary iron, its magnitude being about ten times greater than that in the latter iron.

2. In specimen No 1, the axis of which subtends a small angle with the tetragonal, the magnetic expansion rapidly increases in weak fields and then slowly, tending to an asymptotic value, as the field increases (Fig 3, *a*).

3. In specimen No. 5 the axis subtends a small angle with the trigonal. A very small magnetic expansion is observable in weak fields; above a field of 50 it is always negative, the amount steadily increasing with the field (Fig. 3, *c*).

4. In specimen No. 3, subtending a small angle with the digonal axis, the course of the curve is similar to that in specimen No. 5; the maximum elongation and the inversion field are a little greater, but the contraction in strong fields is about ¼ of that in specimen No. 5 (Fig. 3, *b*).

From the above results it is to be concluded that the magnetic expansion in the direction of the tetragonal axis is always positive for all magnetising fields, and that the expansion in the direction of the trigonal axis should always be negative, the small initial expansion actually observed being due to the deviation of the axis of the specimen from the trigonal axis. The expansion curves in specimens Nos. 2, 3, 4 may be considered as the combined effect of the above two. The magnetic expansion in ordinary iron consisting of microcrystals is a differential effect of the expansion and contraction above referred to, the crystal axes being distributed at random. The smallness of the magnetic expansion of ordinary iron as compared with that of the single crystal, as well as the course of the expansion-curve, are all explained on the above view.

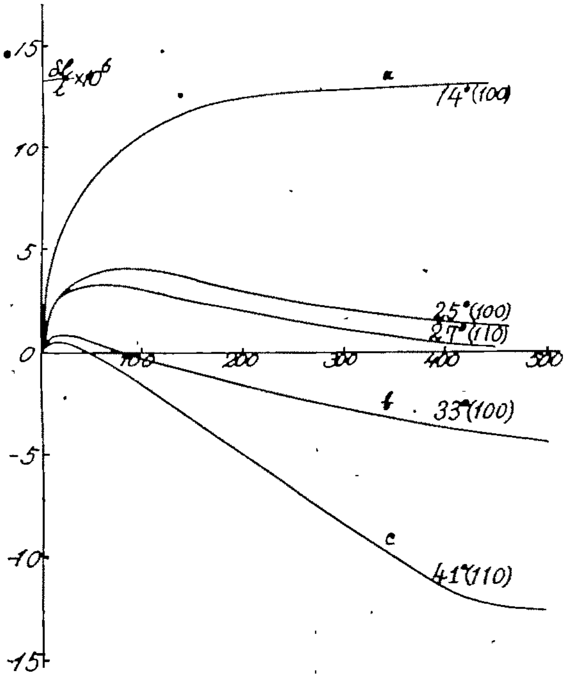

FIG. 3.—Curve showing magnetic expansion of single crystals of iron differently oriented with regard to the principal axis of the crystals.

The result obtained for the magnetic expansion agrees with that obtained by Heap (*Phy Rev.*, 24, 1924) in the case of magnetite. The sharp breaks in the magnetisation curve can be expected from the theory of crystal magnetisation put forward by Dr. J. Okubo and one of the present writers (*Sci. Rep.*, 5, 1916) ten years ago. This theoretical part, together with new interesting facts, will be dealt with in a further communication.

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The Physical Basis of Insect Drift.

THE writer in the issue of NATURE for September 5, 1925, summarised available data in regard to insect drift and only incidentally alluded to the meteorological phases. Very recently the occurrence of hundreds of thousands or even millions of black aphids, *Dilachnus piceæ* Panz., and a flower fly, *Syrphus ribesii* Linn. (C. S. Elton, *Trans. Ent. Soc. Lond.*, pp. 289-299, 1925), on the ice-covered wastes of North-East Land, Spitsbergen Islands, north latitude 80°, has renewed interest in the subject, particularly as these insects must have drifted more than 800 miles near the extreme north. This could scarcely have been a movement in response to some strong instinct, and the same is very probably true of the Coccinellids recorded very recently from the crater of Vesuvius (*Ent. Record and Journ.*, Variation 37, 143, 1925).

There are physical explanations for these movements and many others noted in our earlier cited paper. A moderately strong favourable wind is all that is necessary to account for widespread transportation of insects capable of sustaining themselves in the air. The latter may or may not be correlated with what we know as a strong flight. It is well known that ordinarily air currents near the surface of the earth, during the milder season when insects are abroad, are usually more or less unstable, and therefore we do not expect extensive drifts in this manner, and the general tendency has been to explain any widespread movement as a migration, that is, a somewhat determinate or purposive movement by hosts of insects. This attitude is due in part to our very limited knowledge as to the movements of the upper air currents, and secondly to the assumption, based largely upon lack of data, that insects remain near the surface.

The recent development of aerial navigation has demonstrated the occurrence of convectional currents at considerable heights, 1000 feet to even 3000 or 4500 feet. A velocity of 2000 feet per minute has been recorded for such currents. The significance of these is that they may, and undoubtedly do, serve as elevators, as it were, to carry insects into the upper air, and once at a considerable height, it is not difficult to realise that horizontal currents of great velocity might carry these insects possibly thousands of miles before they descend to the surface. This latter is rendered more probable by the fact that wind velocities increase greatly as one ascends in the free air to 100, 200, or even 300 miles per hour. The 5¼ in. of dust swept from the Sahara Desert during the past thirty years and deposited in Europe and also over parts of Africa, Asia, and the Atlantic Ocean, and the transportation of dust 1500 miles from Australia to New Zealand, are concrete examples of what winds may accomplish (*Monthly Weather Rev.*, U.S. Dept. Agr., 50, 301, 1922).

It is well known that there is a somewhat definite circulation of warm air from the tropical or subtropical regions toward the cooler sections of the north. Such a movement of warm air means a return near or at the surface of the earth of cooler air. We readily see what is in the latter, because it is within easy vision. We know nothing about the upper air except the extremely few observations made by airmen in balloons, dirigibles, or aeroplanes, at a time when they are concerned mostly with problems of navigation and can give only incidental attention to such minor matters as birds, insects, and other forms of life.

The large desert areas in Arabia and northern Africa are undoubtedly sources of convectional currents which ascend to considerable heights and move northward, carrying with them, presumably, any light objects which might be in the air, including wandering insects, and possibly millions from nearby localities producing enormous broods. It is easy to see how hosts of the thistle butterfly, *Vanessa cardui* Linn., might be picked up by such convectional currents, carried to considerable heights, drift northward at such elevations, and thus supply all Europe north of a line through the middle of France and south Germany or Switzerland with these insects, a movement suggested by Mr. C B. Williams, some being carried (we believe this is drift rather than flight) even to northern Scotland, Scandinavia, the Shetland Islands, and distant Iceland.

Such a drift would suggest that the warm air currents might extend even nearer to the Pole, and the record of plant lice and flower flies which are given above is conclusive evidence that such must be the case, to a limited extent at least. It is quite possible that other insects are carried into remote northern areas, sometimes in considerable numbers. The mere fact that there are no records counts for little, owing to the impossibility of obtaining from such sections anything which might be considered approximately complete data.

Turning to the western hemisphere, there are several records of enormous swarms of this butterfly, *Vanessa cardui*, being observed in apparent migration in southern California in 1924 and 1926, the movement being from the south-east to the north-west. One of the observers suggests that the source or the origin was either the foothills of the Sierras or the Sierras proper. There is a possibility that these swarms originated at a considerably greater distance. They may have been carried into the upper air in regions bordering desert areas considerably farther south or south-east, in much the same way as suggested for this insect in the eastern hemisphere, since we have in both extensive desert areas constantly producing convectional currents, and after a certain altitude is attained, the probabilities of extensive drift are certainly excellent.

There are interesting records which, while they undoubtedly represent extremes for wind currents near the surface of the earth, may be taken as reasonably suggestive of conditions at some elevation where air movements are not hindered by friction These are the notable gales at Point Reyes Light, Calif. (*Monthly Weather Review*, U.S. Dept. Agr., May 1903, p 227), in May 1902 and 1903, the first lasting six consecutive days, with an average velocity of 50 miles an hour and an extreme velocity of 120 miles an hour, and the second of nine days' duration, with an average velocity of 54 miles an hour and an extreme velocity of more than 90 miles per hour There can be no doubt regarding the ability of the winds to transport insects and other drifting objects long distances, and with a multitude of areas favourable for the development of convectional currents of moderate to considerable intensity, it seems quite probable that many insects are raised to somewhat high altitudes and carried long distances, some species in large numbers, and presumably many are represented only by scattered specimens, owing to their seldom breeding locally in great abundance.

It is believed that a recognition of these forces and an understanding of the agencies involved will assist materially in solving problems in connexion with the extensive movements of flying or drifting insects.

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(State Entomologist.)

New York.

The 'Gas Laws' in Surface Solutions.

IN a letter to NATURE (April 3, p. 484), Messrs. Adam and Jessop disagree with the findings of MM. Marcelin (*Ann. de Physique*, November-December, 459) and Delaplace (*C.R.*, 180, 2020), concerning the relation between the pressure, (F), of the surface films of oleic acid and the area per molecule, (A). The latter investigators find the relation $FA = kT$, while the former find A largely independent of F. It should be noted that Langmuir (*J. Am. Chem. Soc*, 39, 1868) obtained two types of FA-curves: when the films were formed on distilled water the FA-curves were steep like those of Adam, and represented *irreversible* conditions, when expanded on acid solutions the films gave flatter FA-curves, more like those of Marcelin, and were (presumably) reversible. Evidently there exists a disturbing factor and it will repay to inquire into its probable nature.

A little consideration will show that attempts to express the energy relations of surface films as a function of temperature alone cannot be successful, and that Delaplace's formula $FA = kT$, while true for dilute surface solutions with area per molecule greater than 5000 sq Å.U., cannot be applied to more concentrated films; on the other hand, Marcelin's original formula, $FA =$ constant, may be correct under specified conditions. Since molecular surface films are composed as a rule of heavy, highly polar, oriented, molecules which have relatively little freedom of movement, changes in their energy content will not involve changes in heat energy to any large extent. In fact, it has been shown by Einstein (*Ann. der Physik*, 4, 543), and by Harkins (*J. Am. Chem. Soc.*, 39, 354), that the relation between the specific heat of surface (S) and the free surface energy, or surface tension (γ) is $S = -T\, d^2\gamma/dT^2$, and when $d\gamma/dT$ is linear, which is generally the case, *the surface contains no heat, its energy being in potential form*. This is only what may be expected, seeing that heat energy is closely connected with volume and with free movement in three dimensions, and that oriented molecules, in a two-dimensional continuum, can possess but little energy of translation.

It seems much more rational to express energy relations of films in terms of surface (A), of surface pressure (F), and of (E), the *potential of the surface energy*,—these three variables corresponding to the familiar p, v, T, of thermodynamics Unfortunately, we know very little about the real nature of the potential E. It is probably an electro-chemical potential depending on the chemical nature of the film and on the electrical potential. We do know that in disperse systems certain ions have great influence on the degree of dispersion, and therefore on the surface energy; we know that there is a close connexion between potential difference and surface tension (Lippmann-Helmholtz equation); that the surface tension of mercury may be calculated, with certain assumptions, from the energy of the double layer formed by the positively charged atomic nuclei and the negatively charged electrons (Frenkel, *Phil Mag.*, 33, 6, 297); and the writer has shown that electrical energy may be changed into surface energy ("Electrical Dispersion of Liquids," *J. Phys. Chem.*, 29, 1289). Consequently the area of the molecular surface film may be expected to be a function of an electrochemical potential (E), just as the volume of gases is a function of the heat potential (T). By analogy we should expect a 'law' of the form $AF = kE$ (or kE^2, if the potential is to be expressed in units of ordinary electrical potential). Below a certain value of the potential E the molecular surface film will behave like a 'liquid' and steep FA-curves, like those of Adam, will be obtained; above that value, the film will behave like a gas above its critical temperature, giving FA-curves like those obtained by Marcelin and by Langmuir. The fact that experiments were carried out sometimes under (electrically) adiabatic conditions and sometimes under 'isoelectric' (corresponding to isothermal) conditions, possibly explains the 'hysteresis' of the curves obtained by Langmuir with films on water, and the (presumable) reversibility when acidified water was used.

Naturally, only 'ideal' cases follow the relation $FA = kE$. One may define an 'ideal film' or 'ideal colloid' as *a system all surface and no volume*, in the sense that *its energy is a function of the potential E only*. The 'ideal colloid' is, no doubt, as difficult to find as the 'perfect gas' is. Perhaps some of the body colloids come nearest to the ideal state, for we know, much to our discomfort, that they claim the temperature to be a constant, and a variation of a few degrees is as much as they will stand without 'giving up the ghost.' Yet the human organism is an extremely efficient machine, and its efficiency is due to the fact that it does not derive its energy from wasteful heat changes, more and more we come to consider it as an electro-chemical machine working under nearly reversible conditions. It is known, for example, that muscular action is accompanied by changes in the hydrogen-ion concentration (formation of lactic acid); if we had an ideal colloid composed, for the sake of simplicity, of closely packed molecular films of thickness, say, 1×10^{-6} cm, a variation in their potential due to a change in the hydrogen-ion concentration would readily produce a difference of 10 dynes in their surface tension (as in some of Langmuir's experiments); that would enable each square centimetre of cross-section of the ideal colloid (in this instance, the muscle) to lift a weight of approximately 20 lb. To conclude: let us follow Nature's lead and, assuming the temperature to be a constant, determine the electro-dynamic laws which govern the energy relations of 'oriented' molecules.

VICTOR COFMAN.

Research Department,
Armour and Company,
Chicago, Illinois, April 23

The Oxidation of Ammonia.

IT is regretted that there is an error in the second equation of those suggested in NATURE of April 24 which makes the scheme there given impossible. The writer still considers that nitrohydroxylamic acid is a possible intermediate product, as will be explained below, but it cannot be derived as previously given. Before giving alternative schemes it may be interesting to review briefly the facts to be explained.

A suitable scheme of reactions should explain some such set of data as the following, which is taken from records of experiments made for the Munitions Inventions Department during the period 1917–1919. These records have been in proof for two years but have not been published.

(1) The platinum catalyst, consisting of gauze of 0·1 mm. diameter wire with 80 meshes to the linear inch, through which the mixture of air (or oxygen) and ammonia is passed, exhibits an activity increasing from a very small value with unused metal to a maximum attained, in the case of a single gauze, after 14 hours running with an amount of ammonia oxidised of about 1 gram per sq. in. a minute. This is accompanied by a change in the appearance of the platinum from bright to grey, and has been shown by other experimenters (see Rideal and Taylor, "Catalysis," fig. 10) to be due to a remarkable efflorescence on the surface. This is similar to that observed by Newbery in experiments on overvoltage and seems to suggest that it is due to the expulsion of gases which have been dissolved in the platinum and have perhaps interacted there.

(2) The rate of oxidation is very great With two gauzes and ammonia-air mixtures containing from 9·1 to 13·8 per cent. ammonia by volume, a time of contact of not more than 0·000155 sec. was sufficient to ensure an oxidation of 82·6 to 94·2 per cent. in various experiments. The results were practically the same (87·6 to 94·4 per cent.) with a time of contact of 0·00062 sec., whilst with a longer time of 0·00093 sec. there was some falling off in the yield (63·7 to 89·1 per cent.). The higher yields usually correspond with lower ammonia content of the initial gas. In the case of mixtures with oxygen and steam, with a time of contact of 0·000155 sec. the oxidation was 98·3 per cent and the output greater than with air. With very slow rates, both in the case of air and oxygen, the yield fell below 70 per cent.

(3) The conversion was practically the same with mixtures in which the air varied from the amount required to form nitrogen trioxide, N_2O_3, to that required to form nitrogen pentoxide, N_2O_5, although the best working appeared to correspond with the former. Below N_2O_3 the yield is smaller, and it appears that more oxygen is required than for $4NH_3 + 5O_2 = 4NO + 6H_2O$, both with air and with oxygen and steam. In only two experiments yields of more than 90 per cent. were obtained with the nitric oxide ratio, but generally lower conversions were found with this ratio.

(4) In the experiments with pure oxygen (diluted with steam) the sole products of combustion appeared to be nitric oxide and water, since the gas coming from the converter could be completely condensed by cooling into liquid nitric acid. No nitrous oxide is formed and it is reasonable to assume that none is formed with air, although this was not tested.

A reaction scheme must therefore conform with the following conditions.

(*a*) Reactions of order higher than bimolecular are improbable.

(*b*) Hypothetical intermediate compounds should not be capable of rapid direct decomposition into nitrous oxide. This makes the formation of NOH improbable.

(*c*) Excess of oxygen above the amount to form nitric oxide, NO, seems necessary.

(*d*) Reactions between gases condensed on or dissolved in the platinum, or labile oxides of platinum and dissolved gases, seem not improbable.

The fact that unconverted ammonia, when it does not appear as such, is accounted for as free nitrogen, makes it possible that such substances as NH_4NO_2 can be formed.

The necessity for excess of oxygen seems to indicate that the primary product is one containing more oxygen than nitric oxide, and since the reaction becomes complete at the nitrogen trioxide ratio it may be that this, or $N(OH)_3$, or nitrous acid may be formed It is also possible to assume the formation of nitric acid, since the decomposition of this could be a slower reaction after the catalyst. Very recent work on heterogeneous catalysis will also allow us to make use of atomic oxygen, and hence the following schemes are possible:

A. (1) $NH_3 + O_2 = NH(OH)_2$.
(2) $NH(OH)_2 + O = N(OH)_3$
(3) $4N(OH)_3 = 4NO + 6H_2O + O_2$.
B. (1) $NH_3 = NH + H_2$
(2) $NH + O_2 = HNO_2$; etc.
C (1) $NH_3 + O_2 = NH(OH)_2$.
(2) $NH(OH)_2 + O_2 = HNO_3 + H_2O$; etc.

Schemes A and B also explain the formation of nitrogen, which would come from ammonium nitrite. A possible source of nitrogen in a gas rich in ammonia is combustion in the gaseous phase, possibly accompanied by flame, owing to local rise of temperature on the catalyst, as in the well-known lecture experiment.

It does not at the moment seem possible to connect the formation of nitrohydroxylamic acid with simpler reactions than those given. Although possible schemes are easily drawn up (*e.g.*, one involving the rapid reaction of $N(OH)_2$ and NH_2 followed by rapid oxidation of the product) they do not, in fact, appear very probable. J. R. PARTINGTON.

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Seasonal Sunshine in Great Britain.

AN article on "Seasonal Sunshine in Great Britain" by Mr. Charles Harding appeared in NATURE of March 20. The results were based on the 35-years' mean, 1881–1915. Comparing south-east England with south-west England and south Wales, Mr Harding says that "the average sunshine for the year in south-east England is 4·49 hours a day, and in south-west England and south Wales, including the so-called Cornish Riviera, it is 4·28 hours. In the winter, south-east England has an average daily sunshine of 1·92 hours, and in south-west England and south Wales the value is 1·91 hours a day; in spring the hours of sunshine for the two districts are respectively 5·50 and 5·36; in summer 6·88 and 6·41, and in autumn 3·46 and 3·31 hours."

An examination, however, of the Air Ministry figures, upon which these values are based, show that more sunshine is experienced in the south-west than in the south-east. The fact is hidden through the district being linked up with south Wales, which has different climatological characteristics. South-west England and south Wales have now been made separate districts by the Air Ministry for forecasting purposes, but the original larger areas are still retained for climatological investigation. The counties included in south-west England have an area of 6548 square miles, and those in south-east England 7224 square miles. As these districts are situated in approximately similar latitudes, there is but little difference between them for purposes of comparison of sunshine values. The addition of south Wales, however, with its additional 4762 square miles of country, brings the south-western district up to 11,310 square miles, and the lowering effect upon the sunshine values is apparent. The results for south-east and south-west England are as follows:

	S E England. Hours.	S.W. England. Hours.
Spring	5·50	5·66
Summer . . .	6·88	6·75
Autumn . . .	3·67	3·68
Winter . . .	1·92	2·61
Year	4·49	4·53

The seasons are:—Spring: March, April, May; Summer: June, July, August; Autumn: September, October, November; Winter: December, January, February. J. B. PHILLIPS.

The Observatory, Falmouth,
April 24.

THE criticism by Mr. Phillips, Superintendent of the Falmouth Observatory, is more a matter for the Meteorological Office than for me. In my article it is stated clearly that the sunshine records are taken from the "Book of Normals," published by the Meteorological Office. Exception is taken by Mr. Phillips to the paragraph he quotes from the article, where it is stated that the values quoted are taken from a "Book of Normals" (M.O. 236, Section 2) giving seasonal normals for several districts; in this the Meteorological Office has combined south-west England and south Wales in one normal. I am not at all sure that I agree with Mr. Phillips in thinking that the Meteorological Office should have separated south-west England and south Wales. I agree practically in the results obtained if these two parts are separated, and I will accept Mr Phillips' sunshine value 4·53 hours for the year for south-west England in which observations are taken for Newquay, Cullompton, Plymouth, and Falmouth. Taking all the stations as used by the Meteorological Office for the normal for south-east England, I obtain for the year 4·47 hours a day, in good agreement with 4·49 hours given by Mr. Phillips; this value is obtained from 9 stations By omitting observations from Kew and Marlborough, and using the remaining 7 stations, the normal for south-east England is 4·62 hours, which is a greater duration than the normal for south-west England.

There is clearly keen competition for a premier record, and without doubt much can be done by the choice of a good position for the sunshine recorder. In my judgment, however the records are considered, certainly for a single station or two south-east England has a higher value of daily sunshine than any station in south-west England, which includes the so-called Cornish Riviera. CHAS. HARDING.

The Original Home of the Banana.

I REGRET that in the notice of my recent discourse at the Royal Institution (NATURE, April 24, p. 597) it is stated that "the available evidence points to South America as the original home of the banana." Reference was made to the views that have been held by various authorities as to the original home of the edible banana, and it was pointed out that from all the evidence at present available the balance was in favour of Indo-Malaya as the probable home of the seedless forms now so widely cultivated.

These forms belong to the subgenus Eumusa, the species of which are all regarded as of Indo-Malayan origin.

There are ancient traditions that the banana existed in Central and South America before the arrival of the Spaniards, and edible bananas certainly existed in Sierra Leone in 1568, no doubt as introduced plants, as those alleged to exist in America may also have been.

Prof. Berry's recent discovery of fossil banana seeds in the Tertiary rocks of Colombia is of great interest, since they belong to a species of the subgenus Physocaulis, the species of which are nearly all African. This discovery proves, therefore, that the genus Musa was represented in South America in prehistoric times.

Whether, however, this fossil species, which is closely allied to *Musa Ensete*, from tropical Africa, is in any way related to the seedless bananas is very doubtful. Nor does it seem very likely that such a species as *M. Ensete* would give rise under cultivation to a form with edible fruits.

The seedless bananas have been so long in cultivation that it seems almost impossible to be certain of their place of origin, but the evidence I think on the whole inclines rather towards Asia than to America. ARTHUR W. HILL.

Royal Botanic Gardens,
Kew, Surrey,
April 29.

The Present Position of the Transmutation Controversy.

IF the genius of John Dalton gave the chemist a freehold title to the atom, the work of Becquerel and the Curies may be said to have transferred the title to the physicist, or at least to have granted him an indeterminable repairing lease of the property. The physicist has made good use of his tenure: he has determined the structure and conditions of stability of the atom, and by embellishing its parts with attractive and repulsive signs, he has thrown light upon many things that were previously obscure, and revealed new avenues of research for the investigator. Except for some tentative efforts to formulate an electronic theory of valency, the chemist has, for the most part, been out of the picture; and even when Rutherford used α-particles to disintegrate certain light atoms, the chemist was denied participation by the circumstance that the quantities of material involved were too minute to come within the range of his most delicate methods. In 1924, however, a vista of golden opportunity arose when Miethe and Stammreich announced that they had obtained from pure mercury gold in sufficient yield to be manipulated and determined by chemical means. The vista, although riddled by the barbed arrows of hostile criticism, is still above the horizon, and only the crucial test of further experimentation can decide its ultimate fate. Meanwhile, it may be of service to attempt a brief survey of recent happenings in this very interesting field of alleged transmutation.

It will be recalled that Miethe and Stammreich passed a strong current at 175 volts through a quartz mercury-vapour lamp containing, according to their statement, mercury free from gold, and that after working the lamp for 20-200 hours, gold to the amount of 0·1-0·001 mgm. was detected by chemical means in the mercury (*Naturwissenschaften*, August 1, 1924; NATURE, August 9, 1924). Afterwards, they found that the formation of gold was not bound up with any definite form of discharge, although a certain critical potential difference or electron velocity had to be exceeded; that the amount of gold produced was proportional to the current-strength and the time; and that the production was facilitated by a high pressure inside the apparatus. When they passed electric sparks between mercury poles in a paraffin dielectric, they found that gold was present in the mercury dispersed along the line of discharge, but not in the liquid mercury constituting the poles. Duhme and Lotz are reported to have observed the formation of gold when a sufficiently powerful current is passed between electrodes dipping into mercury; and investigators in the Siemens research laboratory to have produced gold by bombarding a mercury surface with electrons in a very high vacuum (*Naturwissenschaften*, July 17, 1925). In some of their experiments Miethe and Stammreich observed the production of a metal which resembled silver in its chemical properties. It is important to note that these authors have maintained throughout that the mercury they have experimented upon was in all cases proved to be free from gold by the very same tests which they used to prove its presence in the treated mercury.

In May 1925, Nagaoka reported in these columns that he and his co-workers had passed a discharge of P.D. about 15×10^4 volts/cm. for about 4 hours between terminals of tungsten and pure mercury, using paraffin oil as dielectric, and had detected gold in the resulting black mass of carbon, oil, mercury, etc., by the purple-of-Cassius test and by the formation of ruby glass. In a later communication (*Journal de Physique et le Radium*, 1925, 6, 209) he stated that on passing a discharge through drops of mercury falling between iron electrodes, he observed, in addition to gold, the formation of a complex white metal consisting mainly of silver.

Early this year, in a preliminary announcement to NATURE (January 2, p. 13), Smits recorded the transmutation of lead into mercury and into thallium by means of a quartz lead-vapour lamp consuming 40 amp. at 80 volts. The initial purity of the lead and the subsequent presence of thallium and mercury were attested by the spectroscope. The method was varied by substituting sparks of high current-densities for a continuous current; using 60-100 amp. at make, all the lines of the mercury spectrum were visible after 9½ hours' sparking. Another method, in which sparks at 100,000 volts and 2 milliamp. were passed between electrodes of highly purified lead, immersed in a liquid dielectric, showed the transmutation of lead into mercury, the presence of which was proved by conversion into red mercuric iodide.

A priori objections to these experimental results are not difficult to conceive. It might be thought that heavy atoms, like those of lead and mercury, would be more unstable and therefore easier to disintegrate than light atoms, because their nuclei contain a greater excess of positive over negative charges; but Rutherford's experiments with α-particles showed that the lighter atoms are the less stable. Most of the light elements which he decomposed have an odd atomic number; all, with the exception of nitrogen, have atomic weights that are multiples of that of helium plus 3 units; and none of them except boron exhibits isotopy. Now mercury and lead have each an even atomic number, their atomic weights do not follow the above-mentioned numerical rule, and both elements possess isotopes.

Aston, moreover, has advanced some weighty arguments against the probability of the alleged mercury-gold transmutations (NATURE, December 19, 1925). This transmutation might conceivably be effected by the addition of an electron to the mercury nucleus, or by the expulsion of a proton from it. The chance that an electron would hit a nucleus at which it was fired is remote; and if a mercury atom did absorb an electron its weight would not be sensibly increased. Hönigschmid, however, has determined the atomic weight of Miethe's gold and has found it to be 197·2 (the same as that of ordinary gold), a number which is appreciably different from the atomic weight of mercury. Theoretically, it is possible for a mercury isotope of atomic weight 197 to absorb an electron and so produce ordinary gold; but none of the six isotopes of mercury identified by Aston possesses this atomic weight. The alternative hypothesis, that the mercury nucleus may be disrupted with the ejection of a proton, is held by

Aston to be quite untenable, because the forces employed are "ludicrously inadequate" for the purpose. The components of a nucleus are bound together by forces of the order of millions of volts, and these are not yet available to the laboratory worker, except in the form of swiftly moving α-particles from radium-C, as employed by Rutherford.

Possible explanations of the production of mercury and of thallium from lead have been considered recently in these columns by A. C. Davies and F. Horton (NATURE, January 30, 1926, p. 152), who think that investigators should attempt to determine if hydrogen or helium is evolved during the changes: their production would indicate a disruption of the nucleus, their absence would favour the hypothesis of electron absorption. Up to the present no one has observed the liberation of these gases during the reported transmutations.

Criticisms of the experimental findings of Miethe and Stammreich, and of Nagaoka, centre around the question of the purity of the mercury used by them; Was it really free from gold? The answer to this question must depend upon the analytical method employed and upon the 'personal equation' of the observers. The method used by Miethe and Stammreich was to dissolve the mercury in nitric acid (1 : 4), fuse the undissolved residue with borax (0·1 gm.), and to measure the resulting sphere of gold, if any, under the microscope. They state that the limiting concentration of the detectable gold in an amalgam is 1 : 10^7 to 1 : 10^{12}, and that the amounts of gold obtained by transmutation were within 10^3–10^4 of these limits. In one of their experiments they distilled *in vacuo* 1 kilogram of purified mercury, which showed no trace of gold, with 0·5 mgm. of silver and 0·5 mgm. of gold, until only 1 gram of the mixture was left; in this residue they found *all* the silver and gold that had been put in (*Zeitschrift f. technische Physik*, 1925, 6, 74, 76).

In spite of such evidence, it is freely contended that distillation is not a trustworthy method of separating metals of high boiling-point from mercury, and that all the mercury that has been used in transmutation experiments was auriferous. Stammreich has discussed (*loc. cit.*) the possible ways in which gold might be carried over during the distillation of a gold amalgam. (*a*) It might distil over in virtue of its own vapour pressure. The vapour above the amalgam would contain gold, if only in an infinitesimal amount, and this amount would not sensibly increase when the amalgam was boiled. In the above experiment the vapour pressure of the gold must have been very nearly zero, and any error due to gold distilling over in the vapour phase would be well within the limits of accuracy of the method employed for determining the gold. (*b*) The vapour pressure of a gold amalgam might be higher than that of pure mercury. Such a phenomenon would be against all experience. (*c*) Vapour or minute drops of the (auriferous) mercury used for the mercury-pump might be carried over into the distillate. Miethe and Stammreich state that the distilling apparatus used by them precluded the possibility of such an occurrence.

In support of possibility (*a*), the critics quote the work of G. A. Hulett (*Physical Review*, 1911, 33, 307). This investigator submitted a mixture of 6·75 kgm. of thrice-distilled mercury and 45·5 gm. of electrolytically refined gold to two distillations *in vacuo*, and the second distillate was found by a colorimetric method due to T. K. Rose (*Chem. News*, 1892, 66, 271) to contain nearly 2 mgm. of the noble metal. It will be noted that the concentration of gold in the initial mixture was more than 1300 times greater than that in the mixture used by Miethe and Stammreich (*v.s.*). These authors attribute Hulett's result to spirting or irregular ebullition of the amalgam during distillation.

More recently Riesefeld and Haase have distilled an amalgam containing about 1 part of gold in 10 million of mercury under very carefully controlled conditions, using distilling apparatus specially designed to prevent mercury vapour diffusing back from the mercury-pump, and to prevent gold being carried over mechanically (*Berichte*, 1925, 58, 2828). The distillate was found to contain gold in determinable amount.

In their reply, Miethe and Stammreich adhere to their contention that gold enters the distillate, either from the pump or as the result of irregular ebullition. They point out that the microbalance which Riesefeld and Haase used for weighing their gold had an error of 0·003 mgm. and that this was exactly the weight of the gold they extracted from the third distillate. They note that the isolated gold was not pure, and they reaffirm that the mercury used in their own transmutation experiments was always previously purified from gold, to which end only two or three distillations were required as a rule, although so many as fifteen distillations had on occasion to be performed (*Berichte*, 1926, 59, 359).

In a discussion of this subject held at the third assembly of the Deutscher Physikertag in Danzig (September 1925), it was suggested that gold and mercury might distil over together as a constant-boiling mixture. Prof. Miethe replied that in all constant-boiling mixtures the boiling-points of the components are of the same order (mercury boils at 357° C. under atm. press., gold at above 2600° C.), and that the components are present in commensurable proportions; he had investigated the possibility and had concluded that such amalgams do not exist.

Another suggestion made was that the mercury used for the transmutations may have contained gold in a state unrecognisable by the chemical tests employed, *e.g.* in colloidal solution or as a chemical compound, and that these were afterwards broken down by the electric discharge. There is, however, no experimental basis for this explanation. Finally, it was suggested that a decisive answer could be obtained by collecting the mercury dispersed in the dielectric by the discharge (*v.s.*), purifying it from gold, and then resubmitting it to the discharge: if it was found that more gold was produced, transmutation would be established. The experimental difficulties of such a test would be very great; the highest gold-concentration hitherto obtained in the mercury-mud of the dielectric is 1 : 10,000.

This short sketch of the main issues of the controversy will leave the impression that the question is still *sub judice*. On one hand, we have the perfectly definite statements of Prof. Miethe, who is an experimenter of acknowledged ability, and has shown much skill in parrying the attacks of his critics. On the other hand, the accounts of some of his experiments, notably in regard to the distillation apparatus he employs, are somewhat lacking in precise detail; several investigators have entirely failed to reproduce his results (*e.g.* Tiede, Schleede, and Goldschmidt; Sheldon and Estey, Nature, November 28, 1925, 792; Piutti and Boggio-Lera, Nature, April 24, 1926, p. 604); and the considerations put forward by Dr. Aston still await a reply. Claims to have effected 'the great work' of transmutation have been made at frequent intervals since alchemy fell into disrepute, and their ignoble fate must make us sceptical of more recent contentions; but if these are proved to be baseless, it will be admitted that modern research into the constitution of the atom gave them a rational basis of possibility such as was never dreamed of by the mediæval alchemist, even in his most fantastic flights of imagination.

Since the above account was written, a lecture given by Prof. F. Haber to the Kaiser Wilhelm-Gesellschaft, in Berlin, has been published in the issue of *Die Naturwissenschaften* for May 7, in which he communicated the results of prolonged investigations on the alleged transformations of mercury into gold. These results, which appear quite convincing, show that the gold obtained by Nagaoka and by Miethe and Stammreich did not in all probability pre-exist in the mercury, but was derived from auriferous metal constituting the electrodes or other metallic parts of the apparatus employed.

Prof. Haber has worked out two chemical processes for separating and determining gold in the presence of a large excess of mercury, but in the experiments now recorded he used mercury which had been purified by extremely slow, repeated distillation. Nagaoka's experiment was repeated several times, using a less powerful discharge, which, however, was continued for fifty hours, and gold up to 1×10^{-7} gram was obtained; but Miethe's experiment of passing a discharge through paraffin between mercury poles gave no gold whatever. The mercury-lamp method, when modified to give electrons with much greater velocity, gave small amounts of gold, which, however, did not increase when the period of the discharge was prolonged from four to fifty-six hours.

Using a kind of X-ray tube with a cathode of tungsten wire, an anticathode of strongly cooled mercury, and 30,000 volts, Prof. Haber also obtained gold; in one experiment so much as $1{\cdot}6 \times 10^{-6}$ gram. This led him to examine the metallic connexions of the tube, and he found that whereas the parts of these within the apparatus contained 2×10^{-6} gram of gold before the experiment, only one-fortieth of this amount was present at the end, the difference corresponding approximately with the weight of gold found in the mercury. But the most important evidence he obtained was that gold was never found when he used electrodes completely free from that metal. He analysed electrolytic copper wire, nickel wire, steel screws and Swedish iron, and found them all to be auriferous; only thin tungsten wire contained no trace of gold. The silver obtained in transmutation experiments is believed to have a similar origin.

Prof. Haber does not propose to repeat Nagaoka's experiment with higher voltages, because he foresees little chance of success; voltages of the order of two million might lead to results, but at present one million volts is about the limit for laboratory work.

An interesting feature of the recent work on transmutation is the extraordinary delicacy of the tests now used for detecting gold. Prof. Haber relates that one of his young collaborators suddenly found traces of gold in a material he was analysing, but no one else could confirm the observation on other samples of the material. It turned out that the chemist was in the habit of removing his gold spectacles before he made an observation, and that on the occasion in question he had removed them and then grasped a strip of the purest lead to put into the crucible he was using in the analysis. On another occasion, some one in the laboratory was heating gold to a high temperature, and shortly afterwards a worker *in the next room* detected this metal in a substance which was known to have been previously quite free from it.

High-Frequency or 'Ironless' Induction Furnaces.

The emergence of the high-frequency induction furnace from the scientific worker's laboratory into the world of industrial production has aroused widespread interest. True, induction furnaces have long found successful application in the commercial world, but these have all been characterised by some form of iron core and have operated at relatively low frequencies. Although the possibilities of high-frequency inductive heating were demonstrated so far back as 1905 by Schneider, not much advance was made until 1919, when Northrup published an authoritative paper which renewed interest in the subject. How rapid has been the progress from that date may be judged from the fact that in 1925 high-frequency furnaces capable of handling 600-lb. charges of nickel alloys were in operation.

A high-frequency induction furnace, whether large or small, usually consists of a helix of copper tubing the turns of which are somewhat flattened and are separated from one another by a suitable electrical insulator. Electric currents (or oscillations) of the desired frequency are then passed through the furnace helix or inductor, which would speedily become hot were it not for a stream of cooling water passing through the interior of the copper tubing. Powerful eddy currents are induced in any conducting mass placed inside the helix, and a rapid rise of temperature of the material ensues provided conditions are suitable.

In practice, the charge (or metal to be heated) is contained in a crucible which is separated from the inductor coil by some refractory substance which acts both as a thermal and electrical insulator. The reader will in all probability have already surmised that the simple type of furnace (shown diagrammatically in Fig. 1) required for high-frequency inductive heating is not the most complicated part of the plant. Indeed the design of apparatus for the generation of oscillations of the desired frequency has made the greatest demands on the ingenuity of those responsible for the development of methods of high-frequency inductive heating.

ACCESSORY APPARATUS.

Northrup has produced a 'converter' or oscillation generator which consists essentially of two suitably insulated water-cooled electrodes projecting inside a closed vessel containing some mercury. Arrangements are provided for regulating the height of the electrodes in respect to the mercury level and for filling the upper part of the vessel with either hydrogen or alcohol vapour. Energy is delivered to the electrodes at, say, 50 cycles, and at a pressure of 6600 volts R.M.S. When this 'spark gap' is shunted with an oscillatory circuit comprising the furnace inductor coil and a bank of condensers, high-frequency currents are generated in the furnace circuit. The frequency of the oscillations is determined chiefly by the inductance of the furnace coil and leads and the capacity of the condenser system. This form of 'converter' or oscillation generator seems particularly suitable for units of about 35-40 K.V.A. input, and units of this capacity are finding extensive industrial application at the present time.

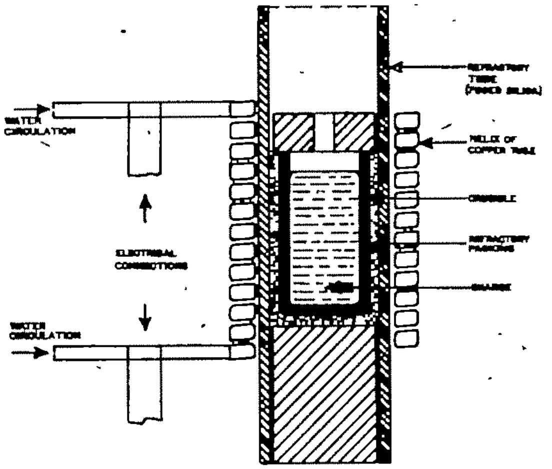

FIG. 1.—Diagrammatic representation of a high-frequency or 'ironless' induction furnace.

The fact that the larger so-called high-frequency furnaces could be operated successfully at moderate frequencies has permitted the use of special alternators for supplying energy direct to the furnace coil. Brace has recently described an alternator which delivered 400 amperes at 250-300 volts at 5000 cycles, and gave an excellent mechanical and electrical performance when used in conjunction with a 225-lb. ferrous furnace. Even lower frequencies have been employed, for Campbell mentions 400 cycles and capacities of 600 lb.

While the mercury gap converter and the alternator as sources of high-frequency currents have been developed in America, France has not been idle, for the Compagnie Électro-Thermique, following the practice of Prof. Ribaud, has produced single-phase equipments involving open spark gaps. These interrupters, fitted with rapidly revolving studded armatures, are reminiscent of the early high-power wireless transmitters, and are probably very robust (a consideration for foundry use).

Both the Northrup converter and the Ribaud rotary gap equipment can, if desired, be modified for use with three-phase supply, thus approximately trebling the capacity of the furnace. Thermionic valves or vacuum tubes can be utilised as oscillation generators for small furnaces, but it will be realised that large valves and the accompanying electrical gear are scarcely proper inhabitants of the foundry. Poulsen arcs and Lepel discharge gaps can also be used as sources of high-frequency energy, but do not appear to have been developed commercially in connexion with high-frequency induction heating.

Although the expression 'high-frequency' inductive heating has often been applied to all induction methods which dispense with the iron linkage circuit, yet the large so-called high-frequency furnaces now operate at frequencies of 400-500 cycles per sec., frequencies which are no longer high, at least from the 'radio' point of view. Perhaps Northrup's expression 'ironless' induction would, if generally adopted, avoid all risk of confusion.

Birch and Ryland, who have attacked the subject from the mathematical aspect, rather suggest a distinction should be made according to whether the electric currents induced in the melt are substantially confined to the skin or flow through the whole volume of the material.

APPLICATIONS IN LABORATORY AND WORKS.

High temperature research already owes a great deal to ironless inductive heating, for it is now possible to adopt refinements which are practically impossible with other types of furnaces. Except in special cases the heat is generated where required—namely, in the charge. Consequently induction furnaces are unique in that the charge is the hottest part of the whole furnace. This fact is all-important in considering the behaviour of refractories surrounding the melt. The inner lining of the crucible must, of course, be capable of resisting the action of the molten metal, but owing to the steep temperature gradient around the charge, a much less refractory material may be used to support the crucible if desired. Frequently the crucible and charge are contained in a tube of fused silica dimensioned so as to pass through the furnace coil (Fig. 1). The close proximity of the water-cooled furnace coil to the central portion of the fused silica tube prevents undue temperature rise, and by making suitable connexions at the ends of the tube, metal melting can be conducted at temperatures well over 2000° C. in a controlled atmosphere or *in vacuo*. As many metals react at high temperatures with air or ordinary furnace gases, the preparation of many high melting-point alloys of great purity has been made possible by the advent of the ironless induction furnace.

High temperatures can be attained so readily in small furnaces working at moderate powers that the chief difficulty of the research worker is to discover refractory material capable of withstanding the action of liquid or gaseous metals in these circumstances. Where exceedingly high temperatures are required, the crucible containing the material to be heated is placed inside a thin cylinder of graphite which is suitably lagged on the outside to prevent undue loss of heat.

Graphite becomes hot much more quickly than metals in the high-frequency or ironless induction furnace owing to its higher and more suitable electrical resistivity. There does not seem great difficulty in actually attaining temperatures in the neighbourhood of 3000° C., but certain inconveniences are apt to arise; vapours and sublimed material obstruct the sight hole, the graphite is apt to react with refractories and even the material in the crucible, and the quantity of gas evolved continuously from the furnace is enormous. Electrical non-conductors (such as glass) can sometimes be melted in ironless induction furnaces by surrounding the crucible with a graphite or metallic sleeve.

Perhaps the best-known application of ironless inductive heating in Great Britain is in the manufacture of the nickel-iron alloys (Mumetal), which possesses exceedingly high permeabilities at low magnetising forces. This alloy is used for 'loading' submarine telegraphic cables, which are thereby enabled to handle traffic at a much greater rate. No fewer than forty-two Ajax Northrup converter units (mercury gap) have been installed for one firm dealing with this alloy. The desirable magnetic properties of the nickel iron alloys diminish rapidly in the presence of impurities, especially carbon, consequently it is not difficult to understand why ironless inductive methods have found favour. Although the weight of melt per furnace (20 lb.) may appear small for some purposes, yet the exceedingly rapid rate of melting enables a considerable output to be maintained.

The cleanliness, ease of control and rapidity of melting have no doubt appealed to those concerned with precious metals, particularly metals with high melting points such as platinum. Further, the violent electrical stirring which is always present in the liquid metal so long as the furnace is in operation, assists in the preparation of the alloys, particularly when the alloying metals possess very different densities. Quite at the other end of the scale of dimensions are the 600 lb. brass, copper, or nickel silver melting furnaces, which may operate at frequencies so low as 400-500 cycles per second.

These ironless, medium-frequency induction furnaces, unlike the true iron-cored low-frequency furnaces, can be operated economically for short periods for alloys of varying compositions, and do not require rings of metal to be left in the furnaces at the conclusion of melting operations, so as to permit the starting up of the furnaces on a future occasion.

While ironless inductive heating finds its chief application in the melting operations, it has also been applied to the heat treatment and hot working of metals. A cold iron or steel bar inserted in a small furnace becomes red hot in a few seconds after the furnace has been put in operation, owing to the hysteresis losses in the magnetic material.

THEORETICAL CONSIDERATIONS.

Those concerned with the practical applications of ironless inductive heating, and with no taste for mathematics, will find articles by Campbell and Gifford of interest. Prof. Ribaud has also given an excellent review of the subject, and he is perhaps unique in bringing together the practical and theoretical aspects of the subject by means of his simple but valuable experiments and conclusions. The accurate measurement of high-frequency resistances, or inductances of furnace and charge, is difficult, and this no doubt partly accounts for the fact that accumulated experience still plays the chief part in the design of new furnaces and plant. There is some ground for believing that the mathematical theories of ironless induction furnaces which have been propounded in the past are a little out of touch with reality.

The two outstanding mathematical accounts of ironless inductive heating are by Northrup and later by the joint authors Birch and Davis, and it is noteworthy that the latter take an exception to a rather fundamental statement of Northrup, namely—"That the effective ohmic resistance of the charge is equal to its reactance."

Again, the reader is apt to be misled by the conclusion of Birch and Davis, who, as a result of their mathematical argument, state as follows: It will be of interest to consider the frequency which gives maximum heating in several cases. For a charge of copper 3 cm. radius

$$p > 1{\cdot}5 \times 10^2 \text{ per sec. (where } p \text{ is the pulsatance).}$$

This corresponds to a frequency of, say, 25 cycles per sec. (approx.). The present writer was able to test this conclusion by experiment. A current of 200 amperes at 50 cycles was passed through an ordinary 4-in. diameter furnace coil, inside of which was placed a cylinder of copper 2 in. in diameter. After five minutes had elapsed the temperature rise of the charge was imperceptible as judged by hand. The same furnace and charge were then attached to an Ajax Northrup converter working on low power, and in the short period of eight minutes the cylinder was found to be red hot. Under the latter conditions, the frequency was in the neighbourhood of 25,000 cycles per second, and the value of current flowing in the furnace coil was known to be much less than 200 amperes.

These experiments would appear to indicate that this statement of Birch and Davis as to frequency requires modification. Generally speaking, exact mathematical prediction as to the behaviour of high-frequency or ironless induction furnaces has not been very successful, possibly owing to lack of complete knowledge concerning them. On the other hand, those engaged in the commercial exploitation of these furnaces in Great Britain have acquired extensive experience as to their various applications, and potential users can anticipate with confidence the performance of a high-frequency or ironless induction plant under definite conditions.

BIBLIOGRAPHY.

Principles of Electric Heating by High-Frequency Induction. E. F. Northrup, *Trans. American Electrochem. Soc.*, 1919, vol 35, p. 69.

Electric Heating by Ironless Induction. E. F. Northrup, *Gen. Elect. Review*, Nov. 1922, vol. 25, No. 11, p. 656.

A High-Frequency Induction Furnace Plant for Manufacture of Special Alloys. P. H. Brace, *Jour. Amer. Inst. Elect. Engineers*, Sept. 1925.

High-Frequency Alternators. C. M. Lafoon, *Elect Journ.*, Sept. 1924, vol. 21, No. 9, p. 416.

Fours électriques à induction a haute fréquence. Ribaud, *Bulletin de la Société française des Électriciens*, 4e Série, Tome 3, No. 29.

High-Frequency Induction Furnace. D. F. Campbell, *Jour. Iron and Steel Inst.*, Sept. 1925.

Electric Furnaces in 1925. W. S Gifford, *The Electrician*, Nov. 27, 1925.

On the Quantitative Theory of Inductive Heating. C. R. Birch and N. Ryland Davis, *Phil. Mag.*, April 1926, vol. 1, No. 4.

Numerous references to other publications dealing with the subject will be found in the abstract section of recent volumes of the *Journal of the Institute of Metals*.

News and Views.

IN modern chemical literature, specially that which deals with the binding of atoms together to form molecules, the nomenclature has become very complex and is altogether bewildering for the student who has not the time for a detailed study of the question. He is left wondering what the difference is between valency, co-valency and electro-valency, and wherein the distinction lies between bonds which are polar, non-polar and semi-polar. In a discourse entitled "Electrons, Atoms and Molecules," published as a special supplement in this number of NATURE, Prof. T. M. Lowry presents some aspects of modern theoretical chemistry. He has succeeded in a few pages in giving a clear account of a few at least of the large number of theories which are at present on the chemical market. In the early paragraphs the author emphasises the debt which the chemist owes to modern physics for the methods which lead to the measurement of molecular dimensions. Due credit is given to X-ray analysis for the recent development of the stereochemistry of solids, while further sections are devoted to the application of electronic theories to specific problems, such as affinity and valency. In assuming that the modern 'child of five' will not hesitate to build up the correct lattice of the diamond when playing with his tetrahedral toy, Prof. Lowry shows the optimism of the true man of science.

THE twelfth annual report of the Carnegie United Kingdom Trust, dated March 12, 1926, contains, in addition to its report, a survey of the activities of the Trust during the past five years. Prof. Adams's report on the Borough Library service led, it is stated, to the Trust's County Library policy which has met with general acceptance throughout England, Scotland and Wales. New opportunities are now being provided thereby in the rural and semi-urban districts for intellectual development and recreative reading at a nominal cost. The County Library system, however, is linked up with the policy of the Central Loan Collections established in London, Dunfermline and Dublin. The future financial positions of these institutions are now under the consideration of the Committee on Public Libraries set up by the Board of Education. The cost of administering these Collections is not shown in the report, but it is known that the income of the Central Library for Students in London depends in part upon grants made by the Carnegie United Kingdom Trust and upon private generosity—sources which cannot be regarded as permanent. The subscriptions received by the Central Library from the borrowing libraries amounted in 1925 to 580*l.* only—in return for the issue of some 25,000 volumes.

THE financial position of the Central Loan Collections is therefore far from satisfactory. We suggest that State assistance might be limited to the free postal carriage of books, coupled with conditional access to the contents of the State libraries. This relief would justify a correspondingly larger contribution from the borrowing libraries, which at present pay the cost of carriage each way. This arrangement would involve a minimum of State interference with, or responsibility for, the administration of the Loan Collections. The taking over by the State of the Central Library for Students would not conduce to a healthy development of the County Library service. The County unit is being applied with good augury of success to other branches of the Trust's policy. Community Councils are linking up the voluntary associations for the promotion of adult education, music and the drama and social services, with the statutory authorities in the counties. Two new departures in the Trust's future activities are adumbrated: (1) a much-needed inquiry into the work of the local museums, and (2) an experimental erection at Sawston in Cambridgeshire of a building to be known as the "Village College," for which the County Authority is to provide the cost of the school while the Trust contributes the rooms for adult education. The experiment is a bold one, and the results obtained thereunder will be followed with interest.

THE problem of finding a permanent protective coating for iron is one of the most important in the whole field of applied science, but one which unceasing effort has so far been unable to solve. In a preliminary communication to the *Zeitschrift für angewandte Chemie* (May 6), Dr. A. V. Blom, of Berne, Switzerland, announces that he has discovered a lead pigment which when applied to iron produces a surface that will not rust. The pigment is made by melting lead in an electric furnace and starting the reaction by passing air and reducing gases through a thin layer of the molten metal. The resulting dross or scale is essentially a pyrosol of lead in yellow lead oxide, and, according to the operating conditions, it is either dense or voluminous; but it must have a particular structure if, after pulverising and mixing with specially prepared linseed oil, it is to be effective as a protective coating for iron.

DR. BLOM has not yet worked out a complete theory of the action of his pigment, but his present view is that the highly dispersed basic lead pigment saponifies the linseed oil, that the fatty acids liberated in this way, and also on drying, react with the lead oxide to produce very finely-divided particles of lead, which, in virtue of their special form and Brownian motion, penetrate the surface of the iron and thus cause a kind of cementation. In experimental tests with sheet iron that had been painted or sprayed with the new pigment, lead was found in the surface of the iron in every case; in one experiment the amount was 1·36 mgm. per 100 sq. cm. of surface four weeks after application. Tests on different kinds of iron ware, extending over several months, gave uniformly good results, and short, drastic tests with steam were most successful. The pigment is extraordinarily adhesive, and although its efficiency is mainly due to the lead particles which diffuse into the iron, the coating itself plays a part in the protection. To realise the potential importance of Dr. Blom's discovery, it may be recalled that in 1922 Sir Robert Hadfield estimated that the world loss due to corrosion in 1920 was 29 million tons of iron, valued at 700 millions sterling.

THE demand for electrical energy has led to the construction of large generating stations and to the laying out of great networks of distributing lines. It is highly probable that these networks will be greatly increased in the immediate future This will necessitate the adoption of very high pressures in order to keep the losses within economic limits. It will also make it necessary to have circuit breakers capable of dealing with enormous currents. The switch houses necessary to control the system will be much larger than the generating stations. This will make the direct control of the system very difficult. It is customary to control the switches from a separate room, in which a switchboard and the necessary instruments are provided. So far as the normal operation of the system is concerned this greatly simplifies the routine work of the attendants; but when anything abnormal has to be done, as, for example, when a generating set has to be switched from one section of the mains to another, there is a serious risk of damage being done to the machines or the network. To obviate this difficulty the Oerlikon Co. of Switzerland describes in its bulletin for January a device which makes errors in operation almost impossible. They provide a miniature "busbar" system where signalling devices indicate automatically which of the different switches and circuit-breakers are closed or open Changes in connexions are first made and considered on the miniature board. When they are seen to be correct, the gear itself is operated in the switch house. The necessary switches are indicated by lighted lamps, so that there is practically no risk of a switching error. This system has been installed in the great Gennevilliers power station near Paris, which operates part of its network at 60,000 volts.

MR. J. E. SEARS, Jun., delivered the Friday evening discourse at the Royal Institution on May 21, taking as his subject "Some Recent Developments in the Art of Fine Measurement," and dealing particularly with the measurement of length. Modern end standards offer superior accuracy of definition to the actual reference standards at present current. Machines are available which are capable of measuring such standards to an accuracy of 0·000001 in. Gauges of this very accurate finish will 'wring' together. This action is due to the presence of minute traces of grease or moisture on their surfaces. The thickness of the wringing film is of the order of 0·0000005 in., the known minimum thickness of a free liquid film. The wave-length of light affords the possibility of a 'natural' standard of extremely high precision, whereas previously natural standards have proved unreliable. Interference methods are used. The direct determination is limited to a distance of about 4 in., but by the use of multiple reflections in white light greater lengths in simple integral numerical relations can be determined. Reference was also made to improved methods of measuring internal diameters, and a description given of a machine designed by the author for this purpose. The nature of the fit of plug and ring gauges under different conditions was shown; when well greased a plug will pass through a ring definitely smaller than itself, the ring expanding elastically by an amount which can be shown experimentally by measurement of its outside diameter. The method of optical projection is very useful for the accurate measurement of profiles.

AT the annual meeting of Messrs. Brunner. Mond and Co, Ltd., held on May 13, Sir Alfred Mond, who has succeeded Mr. Roscoe Brunner as chairman of the Company, announced an important development in the activities of the subsidiary undertaking, Synthetic Nitrates, Ltd., which is the only producer of synthetic ammonia in Great Britain. The plant of this Company is being greatly extended, and before the end of the year 1927 it is anticipated that the present output will be trebled. Among the projected new manufactures are ammonium nitrate, sodium nitrate, nitric acid, anhydrous ammonia, ammonium carbonate and bicarbonate. During the past year Synthetic Nitrates made a profit of 103,647*l.* after allowing for substantial depreciation, and much larger profits are expected in the future. In Sir Alfred Mond's opinion, recent developments in chemical engineering have opened up possibilities of progress the limits of which cannot be foreseen.

THE Prime Minister of the Commonwealth of Australia has announced the personnel of an executive committee the formation of which was recently recommended by Sir Frank Heath as the first step in the reorganisation of the Institute of Science and Industry. The chairman is Mr. G. A. Julius, a prominent engineer of Sydney and president of the Engineering Standards Association. The other two members are Mr. W. J. Newbigin, who is intimately associated with the commercial life of Australia, and Prof. A. C. D. Rivett, who recently succeeded Sir David Orme Masson in the chair of chemistry in the University of Melbourne. It is understood that the new body will possess extensive powers and, together with an advisory council and State advisory committees, will be charged with the organisation and development of national effort in scientific and industrial research.

THE Adelaide Correspondent of the *Times* in the issue of May 20 announces the departure for Oodnadatta of an expedition, financed by Mr. Donald Mackay of Sydney, to explore unknown country in the Northern Territory. The object of the expedition is to carry on research in geography, geology and anthropology. It is also intended to search for precious metals, of which the country west of Charlotte Waters, north of the boundary of Southern Australia and the Northern Territory, is said to contain an enormous wealth. The leader of the expedition is Mr. Herbert Basedow, Protector of the Aborigines, and the author of a recently published book on the Australian aboriginal—a subject on which he is an acknowledged authority. Kinematograph and phonograph apparatus are to be carried, with the view of recording the ceremonies and songs of the almost unknown natives of these parts.

THE third edition of the Kew Hand List of Coniferæ, which includes in this case the Gnetaceæ as well as the Cycadaceæ, has recently been issued by the Royal Botanic Gardens (price 1*s* 6*d*). From the preface to this edition by the Director, Dr. A W. Hill, it appears that a list of the Cycads in cultivation at Kew has not been published before, though it is believed that one or two of the fine specimens growing in the Palm House were brought from South Africa in the days of Sir Joseph Banks. The transference of the Gymnosperms from Museum I to Museum III at Kew has also necessitated the addition of a section to the hand list which deals with the economic properties of the Gymnosperms and serves as a guide to this museum collection The heavy greasy deposit from the London smoke is very deleterious to the conifers, as to all evergreens. Recently the Forestry Commissioners have recognised this fact and a special collection under conditions more favourable to the growth of these trees is being built up at Bedgebury, near Tunbridge Wells, under the control of Kew in co-operation with the Forestry Commission. The Director repeats the statement that the deposits from the smoke block the stomata of the leaves and thus impair their vitality. If, however, recent American work is correct (J. B. Rhine, *Botanical Gazette*, vol. 78, pp. 226-232, 1924) the stomata of the leaves of such plants when grown in places quite free from atmospheric contamination are still found to be blocked by a waxy substance which is readily soluble in alcohol, so that this black deposit is a natural product of the leaf and has no connexion with smoke injury.

THE Field Museum, Chicago, is to be complimented on its decision to publish the results of its curatorial experience in a series of small publications under the heading "Museum Technique." It is fitting that the author of the first number, entitled "Herbarium Organisation," should be Dr. Millspaugh, to whose efforts and organising ability is due the high position of the fine herbarium The various blanks, cards, tickets, index slips, loan forms, and catalogue pages reproduced in the pamphlet may provide useful suggestions to any commencing a large herbarium Such forms look formidable, but when carefully drawn up, as here, save time in the end. The best cases are said to be those of steel, since they are the most dust-proof, do not warp, are more fire-proof, and take up less space. Each pigeon-hole is converted into a drawer by placing beneath its contents a straw-board slide, to the front of which is hinged a one-inch drop that serves as both drawer-pull and label-holder.

WE have recently received a copy of Heft 3 and 4 of a new genetical journal published in Zürich, the *Archiv der Julius Klaus-Stiftung*. It is to appear in four parts per year at a subscription price of 40 Swiss francs The journal is devoted to contributions on heredity, social anthropology and race hygiene, and the publishers are Art Institute Orell Füssli, Zurich The present number contains a short paper on the inheritance of myopia and hemeralopia in man by Dr Gassler, and an extended account of genetical and cytological studies on certain Primula hybrids, by Drs Ernst and Moser Both *P. Auricula* and *P. hirsuta* and their hybrids are found to have 72 chromosomes (octoploid). These interesting hybrids have long been known as *P pubescens* Jacq, and are the origin of garden Auriculas The hybrids produce nearly as much pollen as the parent species, and some of the F_1 types resemble either parent. A coloured plate shows very well the nuances of colour in the flowers and leaves of various types. This journal will form a valuable addition to the numerous genetical publications already in existence.

THE seventh annual meeting of the American Geophysical Union was held in Washington, D C., on April 29 and 30. The six sections met separately before the general meeting of the Union. At the latter there was a symposium on the constitution of the earth, introduced by brief summaries of various aspects of the subject The sections relate to geodesy, seismology, meteorology, terrestrial magnetism, and electricity, oceanography, and volcanology. The section on meteorology held a discussion on questions involving international co-operation, including the co-operative measurement of the sun's general and ultra-violet radiation (and the estimation of the ozone content of the atmosphere), and on the best method of establishing a chain of meteorological stations along the border of the polar basin

SIR J. C BOSE delivered a lecture on May 20 before the Fondation Universitaire, Brussels, on his recent work on sensitivity in plants. His Majesty the King of Belgium and his Ministers were present at the lecture. In recognition of his work in advancing science, the decoration of commandeur, Ordre de Léopold, has been conferred on Sir J C. Bose.

DR. ALDO CASTELLANI has just returned from America, where, at the invitation of the authorities of the Tulane University, New Orleans, he has established and organised a tropical medicine division in the Medical School. During his visit he had the honour of being invited to deliver the Gehrman Memorial Lecture series at the University of Illinois, and later at the annual convention of the American Medical Association and its Medical Exhibition on scientific subjects he was awarded the gold medal, the highest recognition which can be given by the Association. The award "was based on the excellent investigation in comparatively unexplored fields of Medicine and for the perfection of the display" of specimens

THE one hundred and seventh annual meeting of the Swiss Society of Natural Sciences will be held at Fribourg on August 29-September 1 This will be the fifth occasion on which the Society has visited the little town with its comparatively young and vigorous university. Seventeen sections are being organised, covering most branches of pure and applied science; and excursions in the neighbourhood of Fribourg are a feature of the programme Lectures will be delivered by Prof. J. Reinke, of Kiel, on natural forces; by Prof. J. B. Senderens, of Toulouse, on catalysis in chemistry and biology; and by Prof. P. Debye, of Zurich, on molecular forces. All communications should be addressed to the president of the Society, Prof. Dr. S. Bays, Le Châtelet, Fribourg.

REFERRING to his article "Tests of Relativity Theory," NATURE, April 10, Prof. A. S. Eve now writes that a mistake occurs on p. 521, col. 2, line 29. In the sentence "The compromise of Silberstein that in *rotation* there is full drag, and that in *translation* there is a partial drag, will suit the experimental evidence in hand, but no one seriously supposes that such will be the ultimate result of further experiments," the words now italicised should be exchanged. On p. 383 in Silberstein's "Theory of Relativity" it is clearly pointed out that in the theory of the famous Chicago experiment "If there is a full drag, there should be no fringe shift at all," and this is otherwise obvious. Dr. Silberstein pointed out the error to Prof. Eve, and added the following interesting comment: "Nor is there actually a 'compromise'; absence of *spinning* (rotational) drag is well compatible with the presence of a partial (and even almost complete) *translational* drag."

MR. F. EDWARDS, 83a High Street, Marylebone, W.1, has issued a catalogue (No. 481) of upwards of 300 second-hand works on botany, general natural history and zoology, some rare. A number of herbals are included. The catalogue can be obtained free upon application.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A junior lecturer in botany at the Royal Technical College, Glasgow—The Director (June 7). A junior engineer at the Forest Products Research Laboratory of the Department of Scientific and Industrial Research, South Farnborough—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (June 12). An assistant lecturer in zoology at the University College of North Wales, Bangor—The Secretary and Registrar (June 14). One or two assistant superintendents in the Geological Survey of India—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (June 26). A works chemist at a large firm of woollen manufacturers in the West Riding of Yorkshire—The Secretary, British Research Association, Torridon, Headingley, Leeds.

Our Astronomical Column.

THE NOVA IN MESSIER 61.—Several additional observations have come to hand of this nova, the detection of which by Prof. M. Wolf and Dr. K. Reinmuth was announced in the issue of NATURE of May 15.

The discoverers note (*Beobach. Zirk.*, Nr. 20) that a plate taken on April 15 shows no trace of the nova, while on May 9 it was between mag. 13 and mag. 14, being slightly fainter than the 13th mag. star south preceding the nucleus at a distance of 2′·6. Lorenz gives the position of the nucleus of the nebula as R.A. $12^{h}\ 16^{m}\ 48^{s}{\cdot}58$, N. Decl. 5° 1′ 43″·5, equinox 1900·0.

The nova was observed at Greenwich both visually and photographically on May 15 and 16 by Messrs. Melotte, Merton, and Steavenson The *Times* of May 21 also reports that it was observed at Harvard University Observatory. On the very doubtful assumption that the distance of the nebula is 10 million light years it is deduced that the nova is 10 million times brighter than the sun, which would make it the brightest nova on record except that in the Andromede nebula in 1885. But these estimates should not be quoted in the public press without a warning of their extreme uncertainty.

FIREBALL ON MAY 2.—Mr. W. F. Denning writes that "A magnificent fireball was observed on May 2 at $23^{h}\ 30^{m}$ G.M.T. from various places in the N.W. of Ireland. Reports have come from Co. Tyrone, Donegal, Londonderry, and other parts, but unfortunately they are not of the required character and give few details of utility for computing the real path of the object. The light it exhibited was astonishing, and some people describe it as of dazzling intensity. An observer at Ballybofey says his attention was attracted by a flash; then a more prolonged light illuminated the whole countryside, and on looking up he saw a large ball of fire which broke up into three or four pieces as it fell to near the N.W. horizon. Another spectator at Dunnamore describes the illumination as quite dimming the 12-volt lamps of the motor in which he was riding. He observed the meteor explode into four fragments. The observations of position are fairly consistent, and prove that the fireball was probably directed from a radiant near β Libræ and that it pursued a path of about 92 miles at a velocity of about 15 miles per second. The height was from 64 to 47 miles, but it seems highly probable that the path was longer than this and that the height at disappearance was less than that given. Possibly the meteor may have descended to within about 30 miles at the termination of its luminous flight, but data of greater accuracy and consistency are needed

COMETS.—*Astr. Nachr.* No. 5440 contains two reproductions of photographs of Ensor's Comet obtained at Bergedorf Observatory. That on March 16, by A. Schwassmann and J. Stobbe, has been already described in this column The other was taken by the Director, R. Schorr, with the reflecting telescope on April 3, the exposure time being 30 minutes. The comet appears as a straight streak 35′ long in Position Angle 310°. There is no nucleus; the head has a diameter of 2′; the tail gradually widens, being 6′ broad at its extremity. The position angle increased by 60° between March 16 and April 3. Another exposure (not reproduced) was made on April 13, lasting 1 hour. The comet appeared as a very faint glimmer, magnitude 17, the tail being 30′ long and 5′ broad, position angle 0°.

Orkisz's Comet was photographed at Bergedorf on May 2, its magnitude being 16. It was under observation for an interval of 13 months, which will enable the orbit to be deduced with great precision.

Research Items.

CALIFORNIAN ANTHROPOMETRY.—A valuable contribution to the physical anthropology of the American-Indian people is made in a comprehensive study of the available measurements on the living and on crania which is published by Mr. Edward Winslow Gifford as Part 2 of vol 22 of the *University of California Publication in American Archæology and Ethnology*. The aborigines of California fall into two main groups, one low-faced, the other high-faced. The low-faced group constitutes the Yuki type, with high nasal index, relatively low cephalic index, and short stature The high-faced group is variable in nasal and cephalic index and medium to tall in stature. This group is divided into a broad-headed sub-group of wide distribution—the Californian type, divisible into narrow-nosed, broad-nosed, and tall; and secondly, a narrow-headed, narrow-nosed sub-group, the Western Mono type. The cranial material is not so representative in distribution as the measurements from the living; but it affords seven types, of which three may be local specialisations of a fundamental type with medium facial, medium to high cephalic, and medium nasal indices. This fundamental type appears to have as its nearest living representative the Californian type. Unfortunately a comparison between living and cranial measurements is impossible, as the two classes of material do not coincide in distribution In the case of the Yuki, where there is adequate material, there is practically no difference between living and dead. Nowhere is there any indication of stratification of types. In the matter of extra-Californian relations, Boas reports a type from the coast of British Columbia with cephalic index 77-81, which resembles the Yuki, while the Californian type suggests Boas's brachycephalic type, the Tinneh. His Kwakiutl and Shuswap suggest the narrow-nosed sub-type of the Californian. The Athabascans of California do not correspond to this type, such of them as the Wailaki and the Kato being of the Yuki type

MANIFESTATIONS OF LIFE—The editor of *Scientia*, Prof. E. Rignano, has written in the February issue and the four preceding issues of his journal a series of articles on "Les Manifestations finalistes de la Vie," in which he challenges the mechanistic position. He discusses among other subjects development and regeneration, adaptation, the behaviour of the lower organisms, reflexes and instincts At the end of the article on the lower organisms he summarises the facts and considerations on their movements, and points out that no physico-chemical process in the inorganic world in the least resembles the avoiding reactions of these organisms, and that no non-living substance exhibits a behaviour influenced by past experiences. In the presence of these facts he writes: Should we not ask if we are not shutting our eyes to the most patent reality if we continue to say that the properties of matter suffice to explain the phenomena of life?

HERRINGS ON THE WELSH COAST.—Volume 1 of a new series of reports on work done in the Zoological Department, University College of Wales, Aberystwyth, issued in December last, has recently been received. The editor, Prof. R. Douglas Laurie, in an introduction gives a list of the researches at present in progress, and expresses a hope that reports will be issued annually The current volume is largely devoted to an account by Mr. E Emrys Watkin of some preliminary investigations upon the herring shoals visiting local waters in 1921 and 1922. During the autumn of 1922, thirteen samples comprising a total of 1989 fishes taken from commercial catches at Borth, Aberystwyth, and Newquay were examined, and data collected on length, sex, degree of maturity, number of rings to scale, and growth observations on the scale. Mr. Watkin concludes that fishes with 3 and 4 rings to the scale formed 68 per cent. of the fishery. A number of distinct schools of herrings visited the fishing-grounds, of which some came to spawn, but others to feed It is to be noted that measurements of growth increments of the actual scale were directly compared, whereas it is usual first to calculate the length of *fish* which by theory corresponds to each of the winter rings on the scale, and then compare these lengths. It is to be hoped that in his future reports Mr. Watkin will adopt the customary practice.

A NEW NEMATODE FROM THE RAT.—Eloise B Cram describes (*Proc U.S Nat Mus*, vol. 68, Art 15, 1926) a new nematode, *Protospirura columbiana*, present in large numbers in the stomach and small intestine of wild rats (*Rattus norvegicus*) captured in the National Zoological Park, Washington. Details are given of the characters of both sexes (the males are 23-43 mm. long and the females 45-100 mm), and a table is given of the known species of Protospirura. Embryonated eggs from the uteri of the female worms were fed, with bread, to cockroaches in which the larvæ were afterwards found encysted, chiefly in the loose tissue in the abdomen and in the thorax. Though encysted larvæ are to be found in the cockroach about one month after feeding the latter with the eggs of the worm, the larvæ do not appear to be infective until about the fortieth day. Such larvæ when fed to rats developed into adult examples; after 53 days they were mature but not fully grown, but after 115 days they had attained the size of the majority of examples found in the naturally infected rats The finding of this nematode in wild rats in the Zoological Park, but not in those from other parts of the city, suggests the possibility that the normal host may be a rodent other than the rat living in the Park. "That rats and cockroaches, pests commonly present around such places, may play a part in the dissemination of parasites formerly absent in a country but brought in by the animals in the Zoological Park is a possibility the recognition of which may have a practical significance"

THE CHLOROSIS OF FRUIT TREES—Messrs. T. Wallace and C. E. T. Mann present some very interesting if puzzling data as the result of the chemical investigation of the foliage of chlorotic apple trees in the *Journal of Pomology and Horticultural Science* (Vol. 5, No 2, March 1926) They have been studying examples of chlorotic foliage, occurring in soil rich in calcium carbonate, in which there is every reason to associate chlorosis with the calcium carbonate; in some cases comparison was possible with normal foliage, in other cases with green foliage obtained as the result of spraying the trees with sulphate of iron. In either case the same general types of difference between green and chlorotic foliage were noticed and may be summarised as follows: (1) The percentage of dry matter is higher in the green leaves; (2) ash content is usually higher in the chlorotic leaves, (3) the percentage of calcium is markedly lower in the ash of the chlorotic leaves, (4) the percentages of sodium and especially of potassium are always much higher in the ash of the chlorotic leaves These conclusions are amply justified by the experimental data quoted and appear very intriguing. Why, for example, should spraying with sulphate of iron produce this marked reversal in the relative proportions of calcium and potassium in the ash of the foliage leaves?

THE 'FLOWERING' OF LAKES.—The phenomenon termed by the ancients *flos-aquæ* and described by Pliny, who observed it on Lake Bolsena, is not of frequent occurrence on the large sub-alpine lakes, but it appeared during last August on Lake Como. The results of its investigation have now been presented to the Reale Istituto Lombardo di Scienze e Lettere. The 'flowering' was manifested over almost the whole surface of the lake simultaneously and persisted for several days, during which perfect calm prevailed, gradually disappearing when the wind rose. By means of a small net several decilitres of a pea-green gelatinous mass was obtainable in a few minutes, and this proved to be *Microcystis æruginosa* (Henfrey) Lemm The asphyxiation of fish sometimes occurring when this 'flowering' takes place on small lakes, is usually the cause, and not an effect, of the phenomenon. In sheltered pools subject to frequent and abundant flowering, the algal mass may, however, favour the growth of bacteria and thus lead to such consumption of oxygen and production of non-respirable gases as to render fish life untenable.

VEGETIN.—In the *Rendiconti* of the Reale Istituto Lombardo di Scienze e Lettere, Prof. Montemartini gives the results of experiments made with a fungicide known as vegetin, which is an impalpable, black powder and has carbon as its fundamental ingredient. The experiments were made with leaves of potato, tomato, mulberry, Broussonetia, fig, Ricinus, horse chestnut, and *Tropæolum majus*. Although the efficacy of this preparation as a fungicide is left in doubt, in most instances leaves over which it was dusted performed their metabolic functions appreciably more actively than similar leaves not so treated. A further series of experiments is projected with the view of ascertaining the mechanism of this effect.

THE MINERALS OF BENTONITE.—The first fruits of an important investigation of the mineral composition of clays are presented by C. S Ross and E V. Shannon in a paper dealing with bentonites and related clays, and published in the *Journ. Amer. Ceramic Soc.* for February 1926. Bentonite is a widely distributed clay-rock that has resulted from the devitrification and alteration of glassy volcanic ash. Its characteristic minerals are completely crystalline and have a micaceous habit, high birefringence, and easy cleavage The high absorptive power of bentonite is not due, as has been thought, to the presence of gel colloids, for few of the crystal films are so small as to reach colloidal size The peculiar properties are held to be a consequence of the easy cleavage of the minerals, giving a very great surface area, and of the felt-like texture which facilitates permeability. A large number of analyses of the clay-minerals from bentonite indicates that, like the type montmorillonite from France, the composition of the most abundant mineral is $(Mg, Ca)O\,.\,Al_2O_3\,.\,5SiO_2\,.\,nH_2O$. This mineral has also been recognised in fuller's earth. Beidellite also occurs in bentonites, and has the formula $Al_2O_3\,.\,3SiO_2\,.\,nH_2O$. A third micaceous mineral has the composition of halloysite, $Al_2O_3\,.\,2SiO_2\,.\,nH_2O$, but is visibly crystalline and has a high birefringence.

TROPICAL CYCLONES OF THE PACIFIC.—A description of the storms is given by Dr. S. S Visher and is published as *Bulletin 20 of the Bernice P. Bishop Museum*, Honolulu, 1925 The general characteristic of the cyclones is described, with their distribution and frequency The information has been collated from various sources, and in this way the publication is more complete and of greater value Most of the storms appear to start between 10° and 20° north and south. On an average more than fifty tropical cyclones are said to develop each year in the Pacific Lists are given of the number of storms experienced in each year, and their occurrence is also listed for the several months. A majority of the tropical cyclones of the Pacific move westward and poleward until they arrive in about lat. 20°-30°, and then they recurve and move eastward. Frequently cyclones move more abnormally. Cyclones differ considerably in their speed of travel, the movement of the storm ranging from 1 mile to more than 50 miles an hour: at their initiation they generally move slowly. Tropical cyclones are classified in three types with respect to duration, the short-lived storm lasting a day or two, the common storm lasting three to six days, and the long-lived storm lasting more than a week, some of the long-lived storms are followed for more than three weeks. The storms are classified for intensity. With reference to predicting storms it is stated that the advantage of prediction would be so great that many attempts have been made at forecasting, but it seems likely that it will always be impossible to do more than state the probability of a hurricane occurring somewhere in a rather large region. Much useful information is given on numerous points of interest with regard to cyclones in the Pacific.

EXTINCT AMERICAN CARNIVORES —A number of the *Bulletin of the American Museum of Natural History* has appeared giving a very full account by Childs Frick of certain Tertiary carnivores (vol. 66, art. 1, 1926: "The Hemicyoninæ and an American Tertiary Bear"). The author collects together certain genera, namely, Hemicyon, Dinocyon, Hyænarctos, and Ursavus, into what he terms a 'morphological group,' the Hemicyoninæ A 'morphological group' is explained as a collective term for an assemblage of animals which are united by certain characters but more or less widely separated by others, and is used to avoid the terms 'family or sub-family' with their implication of close relationship. The paper describes in considerable detail the members which form this group, and, as an addendum, a new genus, Plionarctos, of true bears.

A RICH LINE SPECTRUM —In the March issue of the *Journal of the Franklin Institute*, Dr. Marion Eppley describes a simple means of obtaining a series of closely spaced lines of nearly equal intensities between wave-lengths 6678 and 3990 Å.U. for reference and other purposes. The end of a carbon rod of about 0·6 cm. diameter is heated to redness in a bunsen flame and dipped into a dry powder of vanadic acid, molybdic acid, and anhydrous titanic oxide in the proportions 8 : 5 : 2 by weight. The end of the rod is again heated to fuse the adhering powder and the process repeated until a thick crust of the mixture has been formed on the end of the rod Two rods with their ends about 1 cm. apart are used as the electrodes of an ordinary spark arrangement. To identify the lines of this spectrum the spark spectrum of an alloy of cadmium, zinc, lead, and tin in the proportions 35 : 35 : 73 : 30 is photographed upon it. This alloy has several advantages over that used by Hartley.

SOLUBILITY OF CALCIUM SULPHATE.—The solubility of those phases of calcium sulphate existent at the temperature of boiler water has been determined by R. E. Hall, J. A. Robb, and C. E. Colman, and the results published in the *Journal of the American Chemical Society* for April 1926. The solutions were prepared in an iron autoclave with an internal filter consisting of layers of woven cloth supported on a perforated steel frame. Their results and those of previous workers are in good agreement at higher temperatures, but the difficulty in controlling the lower temperatures renders measurements under the latter conditions less trustworthy.

The Atomic Weight of Meteoric Chlorine.—The constancy of the atomic weight of chlorine of marine origin has suggested an investigation of the constancy of the atomic weight of the element from minerals of non-marine origin and of that from meteorites. The determinations were carried out by W. D. Harkins and S. B. Stone, who found the ratio of silver to silver chloride by dissolving pure silver in nitric acid in a long-necked quartz flask and treating it with the different specimens of hydrochloric acid. The constancy of the isotopic composition is shown by the values for meteoric and terrestrial chlorine, given in the *Journal of the American Chemical Society* for April 1926, which are identical within the limits of the very small experimental error.

Benzole Research.—We have received a copy of the Report of the Joint Benzole Research Committee for 1926, giving a detailed account of the work carried out by the Association's chief research chemist, Mr. W. H. Hoffert. The report discusses the relative values of the absorption powers of active carbon, silica gel and ferric oxide gel, in the recovery of benzole, and examines the possibilities of cresol and tetralin as wash oils in place of creosote and gas oil. Most important is the investigation of the tendency of poorly refined benzoles to form resins on storage or when used in internal-combustion engines, with several photographs illustrating the effects of different samples on the production of carbon in a motor-car engine after 100 hours running on a test bench. The results of the tests indicate that the deposits are due to the presence of unsaturated constituents. The report is completed by the addition of a classified bibliography.

Heats of Fusion of Low Melting-Point Organic Solvents.—The heat of fusion of a solvent can be calculated from the freezing-points of two solutions at two different concentrations. The apparatus, described in the February issue of the *Bulletin of the Chemical Society of Japan*, consists of a small vessel immersed in an ether or pentane bath cooled in liquid air, the temperature being controlled by an electric heater. The heats of fusion were calculated from the values of two points falling on the straight line obtained by plotting against the logarithms of the molar fractions.

Accurate Heats of Vaporisation of Liquids.—A paper by J. H. Mathews appearing in the *Journal of the American Chemical Society* for March 1926 describes the accurate determination of the latent heats of evaporation of fifty-nine liquids. The liquid, contained in a glass vessel surrounded by vapour and suspended from the arm of a balance, is heated electrically by a platinum spiral immersed in it. The method gives values which are more trustworthy than those obtained from vapour pressure measurements, since small errors in the determination of the vapour pressures lead to relatively large errors in the value of the latent heat.

Inflammability of Firedamp in the Presence of Blackdamp.—The limits of inflammability of firedamp in atmospheres which contain blackdamp is the subject of a report by H. F. Coward and F. J. Hartwell of the Safety in Mines Research Board (Mines Department. Safety in Mines Research Board. Paper No. 19: The Limits of Inflammability of Firedamp in Atmospheres which contain Blackdamp. H.M.S.O. Price 6*d*. net). It was found impossible to explode air-firedamp mixtures containing more than 25 per cent. of carbon dioxide or more than 38·5 per cent. of nitrogen. The minimum amount of blackdamp necessary to prevent explosion in air-firedamp mixtures lies between these limits and depends on the ratio of carbon dioxide to nitrogen in the blackdamp.

Changes in the Gastric Secretion of Birds.—In his investigations on the stomach of the pigeon, Claude Bernard found that, while the young are being reared, the glands of the first of the three stomachs of the parent birds furnish a lacteal secretion which, while it softens the grains they eat, also modifies this grain so as to render it suitable for the young birds. After a time, however, the stomachs of the parents resume their normal condition and begin again to secrete ordinary gastric juice, which contains from 2·5 to 5 per cent. of gastric acid. Since this acid would be highly injurious to the young, the latter are driven from the nest by their parents and, if incapable of fending for themselves, soon perish of starvation. That this instinctive knowledge of the poisonous character of the normal gastric juice is not shared by all birds is shown by observations by P. J. Kaas, described in the *Atti della Pontificia Accademia delle Scienze* (*Nuovi Lincei*). A nest of five goldfinches, transferred to a cage, were fed morning and evening, through the wires, by the parent birds, until one day, two hours after their morning meal, they were all found dead. Evidently, if the young birds are unable to fly and feed themselves before the time when the gastric juices of the parents revert to their normal composition, they perish, not by inanition, as is the case with pigeons, but by poisoning. It is a singular phenomenon, which has been repeatedly confirmed, that this reversion occurs simultaneously with both parents. The elimination by these means of the individual birds incapable of supporting themselves is regarded as one of the processes by which the preservation of specific characters is effected.

Manufacture of Smokeless Fuel.—In a paper recently read before the South Wales Institute of Engineers at Cardiff, Mr. David Brownlie discussed the production of free-burning smokeless fuel by low-temperature carbonisation by processes involving the compression or briquetting of the charge. Such processes may involve mechanical compression of the viscous charge during carbonisation, preliminary briquetting by means of pitch or other binder, or preliminary briquetting without the use of an externally produced binder. Processes of the last class usually necessitate the use of very high pressures, but a new process (*Delkescamp*) of German origin was described in which a portion of the coal ground to a colloidal condition with water is admixed with the use of quite moderate pressures, and the mixture can be briquetted and then carbonised at low or high temperatures. Mr. Brownlie put forward a strong plea for the further study of low-temperature carbonisation. That it is difficult to establish on an industrial scale is clear from Mr. Brownlie's statement that the relevant processes and patents are numbered by hundreds, yet none of these is known to have established itself permanently.

Vocational Guidance.[1]

THE report under notice is the account of a research in vocational guidance undertaken jointly by the Industrial Fatigue Research Board and the National Institute of Industrial Psychology. Up to the present, most of the work on vocational psychology has been concerned with vocational selection, which is an attempt to choose by scientific means those from a group of applicants who are most likely to be suitable for some specific occupation. In vocational selection, no attempt is made to determine the best careers for those who are unsuccessful in the particular tests given. Vocational guidance, on the other hand, seeks to determine the special qualifications of a child with the view of guiding him into the career best fitted for his abilities. It has a wider outlook than vocational selection, and is of greater social importance; it is, however, a far more difficult study on account of the multitudinous occupations which children can enter and their varying psychological requirements.

Only a hundred children were examined during the inquiry, the main object being to test the possibility of the method rather than the reliability of the results. The first step taken was to select a representative London borough, and then to find out the occupations taken up by 1000 children who had recently left the schools where it was proposed to give the tests. This gave an indication of the labour demand in the district and the relative proportions of the various occupations offering employment. One hundred children—half girls and half boys—who were leaving school within a year were then examined. Their intelligence was tested by oral tests, by non-verbal tests, and by performance tests. These various means of testing intelligence served to discover the special medium through which native intelligence expressed itself, and avoided the error of assuming that intelligence can only be expressed by means of words. Scholastic tests and tests of special abilities were also given, and an attempt was made to estimate the character, qualities, and the home conditions of the children examined.

When all possible information in regard to the children had been gathered, a consultation took place between the psychologists concerned in the research, the teachers, and the members of the care committee. Each child was personally discussed, and no hard and fast rules were laid down as to what particular test scores were required in order to recommend an occupation to a child. Each child was considered specially, and all the factors bearing on his case taken into consideration. Thus it might happen that although a particular child had sufficient intelligence for a certain occupation, yet he was lacking in the special abilities or the character qualities it demanded; when this was the case he would be advised to take up an occupation where the lack of such qualities would be no hindrance. Or a child might have the special qualities demanded by an occupation in a marked degree and yet lack sufficient intelligence to make advancement in the occupation possible, so that to send him into that employment would mean that he would ultimately fail.

After two years, the homes of all the children were revisited and information as to their present employment gathered. Among those children who had been able to enter the employment recommended or one similar to it, 83 per cent. were satisfied and only 2 per cent. were dissatisfied; of those who had not entered the employment advised, 39 per cent. were satisfied and 42 per cent. were dissatisfied. Moreover, fewer changes of place had occurred among those who had taken the advice given than among those who had not.

Although the fewness of the numbers of children dealt with and the shortness of the period which has elapsed since the original advice was given make definite conclusions impossible, yet those already obtained are most encouraging and certainly warrant further research along the same lines. Fortunately this is being undertaken on an extended scale by the National Institute of Industrial Psychology through the generosity of the Carnegie United Kingdom Trust.

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[1] Medical Research Council: Industrial Fatigue Research Board. Report No. 33: A Study in Vocational Guidance, carried out by the Industrial Fatigue Research Board and the National Institute of Industrial Psychology. Pp. viii+106 (London: H.M. Stationery Office, 1926.) 4s. net.

Diffuse Matter in Interstellar Space.[1]

AN attempt is first made to estimate the density, temperature and state of ionisation of gaseous matter diffused through the stellar system. It is concluded that the density is about 10^{-24} gm./cm.^{3}, temperature 10,000°–20,000°, and that atoms are ionised down to 15-20 volts.

The black-body temperature of space is about 3°, but analysis of the processes of interchange between radiant energy and atomic kinetic energy in diffuse gas indicates that ionisation and capture form the main process; and this tends to raise the temperature to the level of effective temperatures of stars independently of dilution of radiation. (Hottest stars must be given the greatest weight.) Against this, temperature is lowered appreciably, but not excessively, by radiation of electrons at encounters without capture (orbit switches). The temperature of diffuse nebulæ will be same as that of general interstellar gas. This temperature cannot be found accurately, because it depends on the distribution of stellar radiation far in the ultra-violet, where it is rash to apply the black-body law; but it is as likely to exceed as to fall short of estimate.

An upper limit to density (about 10[illegible]) is obtained from the dynamics of stellar motions; the gravitational effect of greater mass would make the speeds of stars greater than those which are observed. The more definite estimate (10^{-24}) is based on the extension and distribution of condensations of the medium (diffuse nebulæ) by the application of the theory of equilibrium of an isothermal gas. It is concluded that the central density of a diffuse nebula of typical size is about 10[illegible].

The usual equilibrium formula for the amount of ionisation is modified to apply to matter in a field of 'evenly diluted' radiation. Calcium is mainly doubly ionised, but there is sufficient singly ionised calcium to give *H* and *K* absorption in distant stars. Assuming that the abundance of calcium is the same as on the earth, and using Milne's determination of the monochromatic absorption coefficient, the first calculation gives an *H* and *K* absorption of 1 mag. per 100 parsecs. Neutral calcium is nearly a million times weaker. Sodium is mainly singly ionised, and the first calculation gives *D* lines of neutral sodium about [illegible] strength of *H* and *K* lines. Corrections are indicated which would make calcium absorption weaker and sodium absorption stronger, and it appears that the results are consistent with the appearance of H and K and slightly weaker D lines in stars distant 500-1000 parsecs. If the light passes through a nebulous condensation, the required distance is reduced.

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[1] Summary of the Bakerian Lecture delivered by Prof. A. S. Eddington, F.R.S., before the Royal Society on May 6.

These results are compared with the phenomenon of ‘fixed’ sodium and calcium lines which, according to Plaskett's investigation, must be ascribed to an interstellar cloud. Arguments associating the phenomenon with the stimulation or emission of matter from the star showing the lines appear to be untenable It is considered that absorption occurs evenly along light-tracks; but it is recognised that limitation to stars of type earlier than B3 is not very satisfactorily explained. In most stars of later type (where fixed lines are not marked by stellar lines) the absence may be ascribed to insufficient distance

The dimming of distant stars by interstellar gas would be caused chiefly by electron scattering, but this is insufficient to produce observable effects It is considered that the absence of any reddening of distant stars is no evidence of the transparency of space. It is impossible on the present theory to explain obscuration of stars by dark nebulæ, and the question arises whether we must not admit that these contain non-gaseous (meteoric) matter, in order to account for their opacity.

The accretion of mass by stars moving through the interstellar medium must in general be very much less than loss of mass by radiation, so that there is no appreciable effect on the rate of stellar evolution. It is suggested, however, that there will be sharp differentiation of those stars which have velocities less than the velocity of sound (about 4 km. per sec.) Possibly these may reach a steady mass—a speculation bearing on the association of the B type of spectrum with unusually low velocity and with condensations of interstellar gas.

Research on the Fauna of Malaysia.

THE periodical *Treubia*, the organ of the scientific institutes centred at Buitenzorg, Java, is now in its eighth volume, and it functions as the chief medium for the publication of researches specially concerned with the Malayan fauna It is issued at no fixed dates and each completed volume comprises four parts. In the recent numbers of that journal are various papers of interest to students of zoogeography, and to specialists in taxonomy

Dr. H. C. Delsman, in collaboration with Dr. J. E. de Man (in vol 6, liv 3-4), provides a well-illustrated account of certain edible crabs obtainable in the Batavia fish-market under the Malayan name of *radjungans* The commonest species is *Neptunus pelagicus* (L.), which meets with a ready demand among native consumers. It is identical with the "blue swimming crab" of Australia, which is the chief edible crab in the Sydney markets The species is very widely distributed, occurring continuously from the Red Sea, through the Indian and Pacific Oceans, to Japan. Its presence at Port Said is remarkable and is probably due to the cutting of the Suez Canal. Although this crab is the dominant saleable species in Batavia, there are a number of other species that are sold in smaller numbers. These have been submitted to Dr. de Man in Holland for examination. Among them, *Neptunus sanguinolentus* (Herbst) also occurs around the Hawaiian Islands in abundance; *Charybdis cruciata* (Herbst), with the cruciform mark on its carapace, has been suggested as the crab mentioned in the story, by old writers, connected with the legend of St Xavier and the crucifix, *Podopthalmus vigil* (Fabr.) differs from all other Indo-Pacific swimming crabs by its enormously elongated eye-stalks, which together occupy the whole width of the carapace.

Other papers in the same volume are chiefly concerned with insects, and of these, one of the most interesting is by Mr. Oscar John on termites. This contribution is wider in its scope than the others, since it deals with species from Ceylon, the Malaya Peninsula, and the islands of Java, Sumatra, etc Included in this article is a discussion of post-embryonic development and caste differentiation among such insects. Most of the species belong to the family Termitidæ, and, of these, the economy of *Macrotermes carbonarius* Hag. is very fully illustrated. Of special interest are photographs of the queen surrounded by her attendant workers in the royal cell, which strongly recalls Escherich's well-known figure of the same feature in *Termes bellicosus*.

Vol 7, liv. 2 is devoted to reports on various orders of animals, mainly insects, found in the island of Buru. Mr. J K. de Jong of Amsterdam deals with the reptiles. Twenty-seven species are mentioned, two of which are believed to be new. The papers on insects deal with a number of families of Coleoptera by various authorities. Diptera Nematocera are described by Mr F. W Edwards of the British Museum, and Dr. H. H. Karny of the Buitenzorg Museum has an extensive paper on the long-horned grasshoppers (Tettigoniidæ) found in the island Vol 8, liv. 1-2, is given up to a long memoir by Graf. Hermann Vitzthum of Munich on Malayan Acari, illustrated by more than 100 figures. About one-half the species enumerated are new, and both parasitic and free-living forms are dealt with.

The Scott Polar Research Institute, Cambridge.

THE inauguration of the Polar Research Institute, founded at Cambridge in memory of the late Captain Robert Falcon Scott, took place on Saturday, May 22. The proceedings were somewhat modified by the recent industrial upset, which prevented Dr Nansen and a group of other eminent foreign explorers from attending, so that a lecture on the "Aims of Polar Exploration", by Dr. Nansen, had to be abandoned. However, on the invitation of the Vice-Chancellor, Dr. A C. Seward, a party of some thirty non-residents, of whom more than twenty had crossed one of the polar circles, joined a number of residents at a dinner given by him, and most of the guests were able to visit the Institute in its temporary quarters during the afternoon. Amongst those present at the dinner were Mrs. Hilton Young (Lady Scott), Admiral Sir George Egerton, Rear-Admiral Skelton, Sir J J Thomson, Sir Charles Walston, Sir William Hardy, Sir Geoffrey Butler, and representatives of all the important British Antarctic Expeditions.

At the dinner the Vice-Chancellor, in welcoming the guests, spoke of the honour done to the University of Cambridge by the trustees of the Scott Memorial Fund in handing over to it the care of the Institute and an endowment of nearly 12,000*l.*

Sir T. W. Edgeworth David, in returning thanks on behalf of the guests, spoke of the scarcely touched resources of the polar regions, and of the scientific problems the clues of which are to be found there and nowhere else. He referred also in glowing terms to the man whose name the Institute commemorated, and to his companions. The wonderful sketches of Dr. E. A. Wilson were especially remarked upon, of which some were on view in the Institute in the afternoon.

The toast of the Institute was proposed by Commander Hilton Young and responded to by the Director (Mr. Frank Debenham). Commander Hilton Young pointed out that the Institute now inaugurated should be not only a worthy memorial of the great deeds of the past but also a source of inspiration for the future. The generosity of the Scott Memorial Fund trustees enabled the University to begin the work of the Institute, but in order to erect a building for its accommodation a further 10,000*l.* is required. There must be many who would wish to do honour to the name of Captain Scott and assist in further research in the polar regions.

The Director outlined the means by which the committee of management, consisting of the Vice-Chancellor, Dr. H. R. Mill, Mr. R. E. Priestley, Mr. J. M. Wordie, and himself, hoped to realise the aim of the Institute in assisting polar research. They had seen during the afternoon the nucleus of the collections of books, maps, and polar travelling gear which would gradually become a comprehensive library and museum—a source of information for those who were undertaking research in polar matters, whether by exploration itself or by more academic means. The past discontinuity in polar research was largely due to the fact that the results and experience of one expedition were sometimes not published and were dispersed, so that later expeditions were unable to profit thereby. The Director invited the deposit of original records and technical gear so that such gaps might be bridged. The pictorial side of polar research was not neglected, especially in the pictures of the Franklin Search Expedition, presented by Dr F. H H. Guillemard, those of the 1895 expedition, presented by Mrs. Kriel (Lady Markham), and the fine collection of enlargements of the *Terra Nova* Expedition, the gift of the photographic artist, Mr. H. G. Ponting. The building the committee had in mind to construct when funds permitted would contain provision for the rapidly increasing library, the practical museum, and research rooms, to be used by any one discussing the polar regions, whether working up field observations or preparing to go to make them. In expressing his regret at the absence of many eminent foreign explorers from the gathering, the Director emphasised the international character of polar research, and expressed the hope that there would always be close co-operation between those in charge of the Institute and its well-wishers in other countries.

University and Educational Intelligence.

CAMBRIDGE.—The University has returned to work and with the postponed examinations looming large upon the horizon, the majority of people are looking anxious. This anxiety is in many cases intensified by the fact that some of the tests will now take place within the period allotted to social functions.

The Committee which is engaged in making offers of lectureships and demonstratorships to those entitled to them under the new statutes has presented an interim report dealing with the principles on which it is working. In general, lecturers are being offered a basic salary (for a basic amount of work) of 200*l.* rising to 250*l* and 300*l.* after three and ten years' service respectively. Demonstrators are being offered 150*l.*; in each case a fellowship allowance is to be made to such persons holding these appointments as are not fellows of colleges. A list of those to whom offers have already been made is published, from which it appears that almost all those who have been called demonstrators in the past will now be termed lecturers In point of fact they have, in the vast majority of cases, been carrying out the duties of lecturers for a long time; they will now have an official title corresponding to their actual work, but it is doubtful whether they will receive the seniority to which they are entitled.

Mr. J. Gray, fellow of King's College, has been appointed University lecturer in experimental zoology. Mr. Gray has been engaged on cytological research since the War.

EDINBURGH.—The Curators of the University of Edinburgh have appointed Prof. A J. Clark, at present professor of pharmacology and dean of the Faculty of Medicine, University College, London, to be professor of materia medica in succession to the late Prof. A. R. Cushny, who died on February 25.

LONDON.—The site of 11½ acres behind the British Museum, purchased by the Government for the University of London, has been re-sold to the vendor, the Duke of Bedford, under the terms of the conveyance, which provided that if the site could not be used for the proposed purpose in five years, the vendor should be given the option to re-purchase. The announcement has made a painful impression in the University and cannot fail to have an important bearing on future developments

Convocation on May 11 adopted three resolutions adverse to the recommendations of the Departmental Committee of the Board of Education. These declared that the creation of a Council to control the finance of the University would have "prejudicial effects" upon the University, that the reconstitution of the Senate would be "a grave error," and that necessary modifications of the constitution of the University should be formulated by the Senate and not by a Statutory Commission. It should be added that the meeting was sparsely attended owing to the general strike, and that the terms of the resolutions, though recommended by the standing committee, were not previously circulated. The suggestion that the question should be considered at an adjourned meeting, or that an extraordinary meeting of Convocation should be convened, was not, however, supported. The opposition which the Senate is offering to the report of the Departmental Committee is centred mainly on the status of the proposed Council. A large majority of the members of the Senate would prefer that the Council should be a statutory finance committee of the Senate with a prescribed constitution. A Committee has been appointed by the Senate to draw up suggestions for an agreed reconstitution.

A LIMITED number of seed analysts will be admitted to the fifth course of training to be held this summer at the Official Seed Testing Station, Cambridge, on June 21-July 20, on the following conditions. Applicants must be (*a*) nominated by seed firms; (*b*) recommended by universities, agricultural colleges, and institutions; or (*c*) approved by the Council of the Institute. The examination following the course is also open to approved practical seed analysts Applications must reach the Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge, not later than June 7

Applications are invited by the Empire Cotton Growing Corporation for a number of research studentships—senior and junior—each of the annual value of 250*l* plus certain allowances for travelling expenses, lecture fees, and books Candidates for senior studentships must be graduates who, since taking their degree, have had at least a year's training in research methods, or have done a year's post-graduate work in agriculture, or taken other advanced post-graduate courses. Junior studentships are intended to assist men who, as a rule, have passed all examinations for, and are otherwise qualified to take, a degree qualifying for the senior studentships. Particulars of the studentships and forms of application can be obtained from the Secretary, Empire Cotton Growing Corporation, Millbank House, Millbank, S.W.1. Completed forms must reach the Secretary by, at latest, June 22.

In an article by Prof Grossmann in the *Chemiker-Zeitung* for April 17, attention is directed to the fact that interest in the study by technologists of foreign languages and especially of English, which is of vital importance for the rebuilding of the German export trade, has lately begun to recover from the setback caused by the War. At Charlottenburg a lectureship in "Technical English" has been established, and the English lectures have been very popular. Reference is made in the article to the recent publication, under the name of "Technische Sprachblatter," of a cheap series of instructive diagrams, representing a great variety of mechanical and other appliances, reference to the numbers on which greatly facilitates the memorising of technical terms in the foreign language. An illustration is reproduced showing a cross-section through a street, with no fewer than sixty different objects numbered and indexed below in English and in German. Thus the study of technical terms, which often presents considerable difficulty when reliance is placed upon dictionaries, is very greatly facilitated. A parallel series might be very useful to students in Great Britain.

The fourth biennial conference of the International Federation of University Women is to be held on July 27–August 2 at Amsterdam. A preliminary programme, published in the Federation's *Occasional Paper*, No. 5, specifies the following among other subjects for discussion: the question of an international language, international fellowships for research, recent developments in pre-school education, some results of the inquiry into methods of secondary education. The same Paper contains reports from holders of international fellowships, namely, from Dr. Hanna Rydh, who was awarded 300*l.* by the British Federation of University Women, on "The Age and Art of the Cave Men," and from Dr. Leonore Brecher of Austria, who was awarded 1000 dollars by the American Federation, on "Colour Adaptation of Pupæ," and a summary of publications by the holder of the Swedish Federation prize fellowship for research in science and holders of the Rose Sidgwick Memorial fellowships. A list is given of club-houses in the United States, Belgium, Canada, France, Great Britain, and Italy which offer special privileges to all travelling members of the International Federation. Associations of university women in Bulgaria, Luxembourg, and Roumania were admitted to the Federation in 1925. Egypt, Esthonia, Germany, and Poland have associations which will, it is hoped, be affiliated before long.

Contemporary Birthdays.

May 29, 1855.	Sir David Bruce, K.C.B., F.R.S.
May 29, 1843.	Major Patrick George Craigie, C.B.
May 31, 1845.	Col. Rookes Evelyn Crompton, C.B
May 31, 1863.	Sir Francis E. Younghusband, K.C.S.I.
June 1, 1866.	Dr Charles B Davenport, Ph.D (Harvard).
June 2, 1850.	Sir Edward A. Sharpey-Schafer, F.R.S.
June 2, 1866.	Dr Leonard Erskine Hill, F.R.S
June 3, 1853.	Sir W. M. Flinders Petrie, F.R.S.

Sir David Bruce, though by birth an Australian, was educated at Stirling High School and the University of Edinburgh. He entered the Royal Army Medical Corps in 1883. Assistant professor of pathology at the Army Medical School, Netley, from 1889 until 1894, he afterwards engaged in a series of investigations (constituting in reality his life's work) on the causation of certain diseases affecting man and animals, namely, Mediterranean or Malta fever, cholera, sleeping sickness, tetanus, and trench fever The importance of his discoveries and conclusions in these fields of inquiry are well known The Royal Society awarded him one of its Royal Medals in 1905, and the Buchanan medal in 1922. Sir David was also the recipient of the Albert Medal of the Royal Society of Arts in 1923. He is a corresponding member of the Paris Academy of Sciences.

Major Craigie, who was born at Perth, was educated there at the Academy, and at the Universities of Edinburgh and Cambridge. He has carried out much official work in agricultural matters and in statistical inquiries for successive Governments and for public authorities In 1900 he was president of Section F (Economics) of the British Association, and in 1902 president of the Royal Statistical Society. He was, from 1897 until 1906, assistant secretary of the Board of Agriculture and Fisheries. He has been Gilbey lecturer in the history and economics of agriculture in the University of Cambridge

Col. Crompton was educated at Elstree and Harrow. Entering the army after school life, he was, down to the year 1875, in India with the Rifle Brigade. Afterwards he engaged in electrical engineering, founded the firm which bears his name, and continued as managing director for nearly thirty years. During the early period of electric supply, Col Crompton shared with Mr. Ferranti most of the work of designing the power stations of Great Britain, and abroad in the same field he has developed undertakings. He has been twice president of the Institution of Electrical Engineers Early this year the Faraday Society awarded him its gold medal. Elected by the Institution of Civil Engineers (1910) as engineer to the Road Board, he was responsible for the major portion of the experimental work which led to modern developments. Col. Crompton, after the War, was the recipient of an award from the Awards to Inventors Commission for work on the 'tanks.'

Sir Francis Younghusband, soldier, traveller, and geographer, was born at Murree, and educated at Clifton College and Sandhurst. After attaining his army captaincy in 1889, he was transferred to the Indian Political Department. He has travelled in Manchuria, Chinese Turkestan, the Transvaal, Rhodesia, and in many other parts of the world. Sir Francis was awarded the Founder's medal of the Royal Geographical Society in 1891. His publications include "Wonders of the Himalaya" (1924).

Societies and Academies.

London.

Geological Society, May 5.—**K. A. Davies**: The geology of the country between Drygarn and Abergwesyn (Breconshire). The area, 20 square miles of country, is situated 5 miles north of Llanwrtyd Wells, and 3 or 4 miles south-west of the Rhayader district. The rocks belong to the Bala and to the Valentian series, but the latter only is described in detail. The Valentian rocks rest conformably upon the Bala. The sediments are generally of the mudstone-and-shale type, with subsidiary bands of grit and conglomerate. A full graptolitic succession in the Valentian rocks has been proved. The area lies on the western flank of the Towy anticlinorium, but the strata are folded into a subsidiary syncline (the Gwesyn syncline) and anticline (the Rhiwnant anticline), with their axes parallel to that of the main structure, that is, from south-west to north-east. Faulting is practically restricted to the southern side of the Gwesyn syncline, where for some distance an important strike-fault separates the Birkhill from the Bala rocks. The rocks are highly cleaved, the strike of the cleavage-planes being approximately parallel to the strike of the strata. The total thickness of the Birkhill rocks is similar to that of the Rhayader country, but much greater than at Plynlimon. The Birkhill rocks are thicker on the north-western than on the south-eastern side of the area.—**R. M. Jehu**: The geology of the district around Towyn and Abergynolwyn (Merioneth). The area, about 35 square miles, lies south-west of the Corris district. The rocks belong to the Bala and Valentian series, and consist mainly of mudstones and shales with subordinate bands of grit. The district is on the south-eastern flank of the Harlech dome, so that, in general, the strata strike from south-west to north-east and dip south-eastwards; but the area is crossed transversely by large anticlinal and synclinal folds, the axes of which trend north-north-eastwards in the south and become north-and-south farther north. The Bala or Tal-y-llyn fault runs from south-west to north-east through the area and is marked by the straight, steep-sided Tal-y-llyn Valley. This is probably a tear-fault with comparatively little vertical displacement. The southern part of the area is much affected by faulting, and three main groups of faults may be recognised: namely, (1) an east-and-west group; (2) a north-east and south-west group; and (3) a north-west and south-east group. The rocks are highly cleaved, and the extraction of fossils is thereby rendered difficult. The strike of the cleavage-planes is approximately from south-west to north-east.

Linnean Society, May 6.—**A. W. Hill**: The genus Lilæopsis, a study in geographical distribution. There are some fourteen clearly-marked species. Three occur in N. America from Alaska to Florida and Arizona, one both in E.N. America and in E.S. America, and one in Mexico and in Ecuador. One is found in Brazil and one in the Andes of S. America, another in western S. America and Chiloe, and one in the Falkland Islands and in S. Georgia, while the remaining species are natives of Tasmania, Australia and New Zealand. The leaves are rather in the nature of phyllodes, since a specimen has been found with small leaflets attached to the septate rachis.—**R. D'O. Good**: The genus Empetrum. Empetrum has a very wide but discontinuous geographic range. In the nothern hemisphere it occurs almost everywhere above the latitude 40° N. In the southern hemisphere it was found in western South America below the latitude 35° S., throughout Fuegia and the Falklands, and in the Tristan d'Acunha island group. The abundance of the genus has resulted in the collection of an unusually large number of specimens, which differ considerably among themselves. This variation is due chiefly to the differential development of general habit, degree of hairiness, shape and size of leaf, arrangement of leaves, angle of leaf insertion, sex of flower, and colour of berry, showing three distinct types of variation, 'continuous,' 'compound-continuous,' and 'discontinuous.' Very few of the theoretically possible character-combinations occur, and any individual plant can be placed without hesitation into one of ten distinct units. This feature is due mainly to correlated variation (the association of a particular condition in one variable character with a definite condition in some other character), but also to marked geographical segregation. The generic constitution is best expressed taxonomically by recognising two distinct species, one with a subspecies, a variety and three forms, and the other with three forms.—**J. T. Cunningham**: On the nuptial pads of frogs and toads from the Lamarckian point of view. The nuptial pads of the common frog are thickenings of the horny epidermis on the inner sides of the fore-feet or hands. They are entirely absent in the female. They give the male a firmer hold of the female in the axillary amplexus which precedes spawning. In amplexus, although the male's hands and nuptial pads are partly in contact with the skin of the female, they are also in contact with each other, and the more the female struggles the more tightly are the pads pressed together. There are bones beneath the pads, while the skin of the female in contact with the hands covers the soft abdomen. Thus the nuptial pads are in harmony with other secondary sexual characters in male animals in being related to mechanical stimulation, which is confined to the males.—**B. M. Griffiths**: The phytoplankton of the Isle of Anglesey and of Llyn Ogden, North Wales.—**Miss Isobel Dean**: ***Ainigmaptilon haswelli***, n.g. et sp.; a new alcyonarian type.

Paris.

Academy of Sciences, April 19.—**Paul Appell**: The arithmetical nature of Euler's constant. A correction to the note on the same subject in the preceding issue of the *Comptes rendus*.—**Charles Moureu** and **Charles Dufraisse**. Autoxidation and antioxygen action. The catalytic actions of nitrogen compounds. General considerations. Numerous compounds of nitrogen exert an action on autoxidation.—— **Tzitzeica**: Certain congruences.—**A. Buhl**: Continued groups and the integration of Maurer's equations.—— **Cartan**: Certain differential systems the unknowns of which are forms of Pfaff.—**Georges J. Rémoundos**: Paths of determination and asymptotic values of algebroid functions.—— **Swyngedauw**: The change of velocity of a belt close to the points of contact with the pulley.—**F. Baldet**, **V. Burson** and **H. Grenat**: The magnetic storm and the aurora borealis of April 14, 1926. The magnetograph at Meudon Observatory showed two strong deviations on April 14, and several good photographs of the solar layers were obtained at the same time. In the evening a fairly intense aurora was observed, and simultaneously a strong deviation of the magnetic needle was recorded. It is interesting to note that the interval of time between this magnetic storm and the earlier one on March 9 was nearly exactly $8R/6$, in accordance with the rule discovered by M. Deslandres, that the time interval between magnetic storms is a simple multiple of $R/6$, R being the period of synodic rotation of the sunspots.—Raoul **Ferrier**: The transformation of pre-quantic equations.—Svend Aage **Schou**: The absorption of the ultra-violet rays by aldehydes. Absorption is stronger in hexane solution than in water, and this is interpreted as being due to the formation of the hydrate in water. The absorption of the extreme ultra-violet rays by well purified aldehydes is very small: if this is attributed to the presence of some of the enol form, then the proportion of this in neutral aqueous solution is certainly less than 1 in 15,000.—Michel O **Samsoen** and P. Mondain **Monval**: The specific heat anomalies of vitreous bodies. The case of boric anhydride and glycerine. The specific heats of these substances, plotted as a function of the temperature, show discontinuities similar to those found by the dilatometric method, but the temperatures of transformation do not exactly correspond.—V. **Auger** and J. N. **Longinescu**: Uranium oranges and reds.—A. **Travers**: The mechanism of the oxidation of manganese to permanganic acid by Proctor Smith's reagent (alkaline persulphate + silver nitrate). The mixture of solutions of alkaline persulphate and silver nitrate gives rise to silver peroxide which can be isolated in the form of $3Ag_2O_2 . AgNO_3$. The formation of this peroxide explains the catalytic action of silver nitrate in the oxidation of manganese salts to permanganate by persulphates —Jean Marc **Dumoulin**: The catalytic dehydration of the vinylalkylcarbinols. Trials of various catalysts for this reaction showed that the best yields were obtained by alumina precipitated from the sulphate according to the method of Senderens. Three alcohols have been dehydrated and the resulting hydrocarbons (pentadienes, hexadienes, and heptadienes) identified.—R **Lantz** and A. **Wahl**: Some new derivatives of the naphthoquinones —C. **Dauzère**: The inversions of temperature. A study of the effect of the nocturnal radiation of the soil on air temperature —Ph. **Joyet-Lavergne**: The differences of potentials of oxidation and reduction in the spores of *Equisetum arvense*.—E. **Chemin**: *Colaconema reticulatum*. This was found by A. L. Batters developing in the external membrane of *Desmarestia Dudresnayi*, and was considered by him as belonging to the genus Colaconema (?). The author gives further details and considers that the interrogation mark may be removed as the genus is undoubtedly Colaconema.—R. **Combes**: Study of the autumnal migration of the nitrogenous substances in the oak, by analysis of whole plants. By the analysis of seedling oaks it was shown that while changing their colour the leaves lose more than half their nitrogenous substances, and this accumulates in the living organs. During this migration the amount of nitrogen in the whole plant does not vary sensibly.—Marcel **Brandza**: Polychromy in Myxomycetes living in full sunlight.—E. **Aubel**, L. **Genevois**, and J. **Salabartan**: Remarks on the culture of a yeast in a synthetic medium.—Alphonse **Labbé**: A new halophil copepod, *Parametis sanguineus*.

COPENHAGEN.

Royal Danish Academy of Science and Letters, November 27, 1925.—H. A. **Kramers**: Some remarks on the theory of absorption and refraction of X-rays. The general connexion between the absorption and refraction of electromagnetic waves can also be traced in the X-ray region. It allows of a simple explanation of certain features of the experimental laws of X-ray absorption, and leads to definite predictions regarding the dependency of the refraction on the wave-length.

December 11, 1925.—C. **Juel**: Congruence of the second degree. The congruence of straight lines in space can be defined as a congruence contained in a linear complex which is of the second order and the second class and has 0, 2 or 4, or else an infinite number of straight lines in common with each hyperboloid in the complex. This congruence is algebraic, and is determined by purely descriptive results.

January 15.—Niels **Nielsen**: (1) Note on certain developments of a holomorph function. Applying the principle of *renversement* (*Journal de Crelle*, t. 132), two developments are indicated of a holomorphic function in the neighbourhood of the origin, developments of which the region of convergence is generally closed. (2) Research on cylindrical functions and on certain analogous functions. Research on derivatives of the function of Lommel, taken in relation to two parameters, and on homogeneous and linear differential equations of the fourth and sixth order, obtained for their above-mentioned derivatives. Integral representation of these functions and certain relevant developments in infinite series.

January 29—Niels **Bjerrum**: Studies on ion-association. (1) The influence of ion-association on the activity of ions by degrees of association which are not very great. An approximate method is given of calculating the influence of this association on the activity of ions.—Th. **Madsen**: The avidity of diphtheria anti-toxin (Th. Madsen and S. Schmidt). The rate of reaction for the neutralisation of diphtheria with anti-toxin varies considerably for different anti-diphtheric sera. This appears from experiments both *in vitro* and *in vivo*, and is of considerable importance as regards the curative qualities of the serum.

February 12.—C. **Wesenberg-Lund**: Contributions to the biology of the genus Daphnia. The author has investigated numerous races of the genus Daphnia from different localities. Remarks are made upon the systematics, the buoyancy theory, and modern studies of heredity in this genus.

February 26.—C. H. **Ostenfeld**: On the origin of the flora of Greenland. Thanks to the collections made by the many recent expeditions (mostly Danish), the distribution of the flowering plants along the whole of the coast of Greenland is now comparatively well known. Thereby a good base for a treatment of the origin of flora and its ways of immigration is created. A not inconsiderable part of the more hardy species are supposed to have survived the ice-age in Greenland, but a closer limitation of this group is not possible. The main part of the flora, however, has immigrated into Greenland after the maximum extent of the ice-covering, and the immigration has probably had its maximum in the post-glacial warmer epoch which existed also in Greenland. Most of the species have come from N. America, and a much smaller number from Europe. This European element consists of (1) high-arctic species, probably immigrated via Spitsbergen, (2) less arctic species from Iceland, and (3) species which have been introduced in the time of the old Norse settlements.

April 23.—G. **Hevesy**: The exchange of atoms in solid bodies in consequence of heat-movements. Explanations can be offered, on one hand, by the velocity with which one substance diffuses into another, and on the other hand by the magnitudes of their electrolytic conductivities. The paper deals principally with the question of the dependence of the velocity of exchange on the constitution of the crystal aggregate of which the solid is built up.—August **Krogh**: The hormone of the hypophysis in the circulation. Through the action on the melanophores in the skin of the frog, very low concentrations of pituitrin can be determined The concentration is found to be higher in the jugular than in the saphenous vein.

Official Publications Received.

Bulletin of the American Museum of Natural History. Vol. 56, Art. 2: Tooth Sequence in certain Trilophodont Tetrabelodont Mastodons. By Childs Frick. Pp. 123-178. (New York City.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 5, 1923. iv: Meteorologiska iakttagelser i Sverige, Band 65. Pp. x+189. 7 kr. Årsbok, 7, 1925. 1: Månadsoversikt over vaderlek och vattentillgång jamte anstaltens årsberattelse. Pp. 97. 2.50 kr. (Stockholm.)

Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 3, No. 6: Om stormar vid Svealands och Gotalands kuster. Av C. J. Ostman. Pp. 37. 4 kr. Band 3, No. 7: Om sockerbetsodlingens klimatiska betingelser och bevattningsproblemet. Av L. Hogberg. Pp. 11. 1 kr. (Stockholm.)

Bulletin of the National Research Council. Vol. 10, Part 4, No. 54: Quantum Principles and Line Spectra. By Prof. J. H. Van Vleck. Pp. 316. (Washington, D.C.: National Academy of Sciences.) 3 dollars.

Report of the Danish Biological Station to the Board of Agriculture, 31, 1925. By Dr. C. G. Joh. Petersen. Pp. 63. (Copenhagen: G. E. C. Gad.)

Union of South Africa: Department of Mines and Industries: Geological Survey. Memoir No. 24: The Preliminary Report on the Platinum Deposits in the South-Eastern Part of the Rustenburg District, Transvaal. By Dr. Percy A. Wagner. Pp. 39+7 plates. (Pretoria: Government Printing and Stationery Office.) 2s. 6d.

Diary of Societies.

SATURDAY, May 29.

Royal Institution of Great Britain, at 3.—Prof. A. Moret: Une Révolution sociale en Égypte vers 2000 av. J.-C.

North of England Institute of Mining and Mechanical Engineers (Associates' and Students' Section) (Annual General Meeting), at 3.—Discussion on Paper by J. G. Taylor on Coal and its Banded Constituents.—Prof. J. Poole: Notes on the Tour in Belgium and Germany (Address).

MONDAY, May 31.

Royal Society of Arts (Indian Meeting), at 4.30.—Lt.-Col. Sir Arnold Talbot Wilson: The Military Record and Potentialities of the Persian Empire.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—Major L. M. Davies: Evolution.

Surveyors' Institution, at 5.—Annual General Meeting.

Royal Society of Medicine (Odontology Section), at 5.30.—Annual General Meeting and Clinical Meeting.

Royal Geographical Society (at Æolian Hall), at 8.30.—Dr. F. M. Chapman: Darwin's Chile.

TUESDAY, June 1.

Society of Glass Technology (at University College), at 2.30.—Sir W. M. Flinders Petrie: Glass in Early Ages (Demonstration and Lecture).

Royal Institution of Great Britain, at 5.15.—Brig.-Gen. Sir Percy Sykes: Shah Abbas of Persia, the Contemporary of Queen Elizabeth.

Zoological Society of London, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the month of May 1926.—Dr. F. Chapman: Exhibition of Lantern Slides illustrating Bird Life on the Barro Colorado Island.—A. S. Le Souef: On the Habits of the Order Marsupialia.—Prof. R. T. Leiper: (a) Some Parasites of Rats in the Zoological Society's Gardens; (b) The Starling as a Factor in the Spread of Gapeworm Disease in Chickens.—S. Zuckerman: Growth Changes in the Skull of the Baboon (*Papio porcarius*).—S. Hirst: Descriptions of New Mites, including Four New Species of 'Red Spider.'—J. H. Power: Note on the Occurrence of Hybrid Anura at Lobatsi, Bechuanaland Protectorate.—H. C. Wilkie: The Ossicula auditus of the Common Badger (*Meles taxus*).

Röntgen Society (at British Institute of Radiology), at 8.15.

WEDNESDAY, June 2.

Society of Glass Technology (at Research Laboratories, General Electric Co. Ltd., Wembley), at 2.15.—J. W. Ryde: A Communication from the Research Laboratories of the General Electric Co. Ltd., Wembley: Opal Glass.—F. F. S. Bryson: The Electrical Conductivity of Glass at High Temperatures.—Edith M. Firth, F. W. Hodkin, M. Parkin, and Prof. W. E. S. Turner: The Influence of Moisture on the Rate of Melting and on the Properties of Soda-Lime Silica Glasses.—Dr. S. English and Prof. W. E. S. Turner: The Physical Properties of Zinc Oxide containing Glasses.

Royal Institution of Great Britain, at 5.15.—Prof. Dayton Miller: Ether Drift Experiment at Mount Wilson.

Royal Society of Medicine, at 5.30.—Sir Jagadis C. Bose: The Action of Alkaloids and Cobra Venom on the Pulse of the Plant and Animal.

Institution of Electrical Engineers (Wireless Section), at 6.—P. W. Willans: Low Frequency Intervalve Transformer.

Society of Public Analysts and other Analytical Chemists (at Chemical Society), at 8.—A. Lucas: Problems in connexion with Ancient Egyptian Materials.

Royal Society of Medicine (Surgery Section), at 8.30.—Dr. W. E. Gye: The Origin of Tumours.—J. E. Barnard: Demonstration on Microscopical Methods.

THURSDAY, June 3.

Iron and Steel Institute (Annual Meeting) (at Institution of Civil Engineers), at 10 a.m.—Presentation of Bessemer Gold Medal to Sir Hugh Bell, Bart.—Sir W. Peter Rylands: Presidential Address.—Report on Heterogeneity of Steel Ingots. By a Sub-Committee of Committee No. 5, consisting of Dr. W. H. Hatfield, T. P. Colclough, W. J. Dawson, J. H. S. Dickenson, A. P. Hague, E. F. Law, S. A. Main, T. M. Service, and J. H. Whiteley.—J. H. S. Dickenson: A Note on the Distribution of Silicates in Steel Ingots.—J. H. Whiteley: Ghost Lines and Banded Structure of Rolled and Forged Mild Steels.—At 2.30.—W. H. Dearden and C. Benedicks: Magnetic Changes in Iron and Steel below 400° C.

Royal Society of Medicine (Laryngology Section), at 3.—Sir William Willcox: Nasal Sinusitis as a Cause of Toxaemia.—Dr. A. Logan Turner and Dr. F. E. Reynolds: A Fatal Case of Leptomeningitis following Operation on the Ethmoidal Air Cells: with Microscopical Demonstration of the Path of Infection.

Royal Society, at 4.30.—Dr. A. E. H. Tutton: The Alkali Perchlorates and a New Principle concerning the Measurement of Space-Lattice Cells.—Dr. T. E. Stanton: On the Flow of Gases at High Speeds.—Prof. G. I. Taylor and W. S. Farren: The Distortion of Crystals of Aluminium under Compression. Part I.—Prof. E. V. Appleton, R. A. Watson Watt, and J. F. Herd: On the Nature of Atmospherics. II.—*To be read in title only*:—Prof. C. H. Lees: On the Determination of the Specific Heats of Gases at Constant Pressure and at Constant Volume and their Ratio by Adiabatic Expansion.—T. G. Room: A General Configuration in Space of any Number of Dimensions analogous to the Double-Six of Lines in Ordinary Space.—C. N. Hinshelwood and W. K. Hutchison: A Comparison between Unimolecular and Bimolecular Gaseous Reactions. The Thermal Decomposition of Gaseous Acetaldehyde.—P. A. M. Dirac: (a) The Elimination of the Nodes in Quantum Mechanics; (b) Relativity Quantum Mechanics with an application to Compton Scattering.—A. Fage and L. J. Jones: On the Drag of an Aerofoil for Two-Dimensional Flow.—F. W. Carter: On the Action of a Locomotive Driving Wheel.

Institute of Pathology and Research (St. Mary's Hospital, Paddington), at 5.—Dr. C. S. Myers: Freudian Psychology.

Royal Institution of Great Britain, at 5.15.—Dr. J. Newton Friend: Iron in Antiquity.

Chemical Society, at 8.

FRIDAY, June 4.

Iron and Steel Institute (Annual Meeting) (at Institution of Civil Engineers), at 10 a.m.—Announcement of the Award of the Andrew Carnegie Research Scholarships for 1926–7.—D. Brownlie: Coal Blending.—W. W. Hollings: Notes on the 'Combustibility' of Coke, and Direct Reduction in the Blast Furnace.—Dr. W. Rosenhain, H. G. Bateson, and N. P. Tucker: Effect of Mass in the Heat Treatment of Nickel Steel.—G. R. Woodvine and A. L. Roberts: Influence of Segregation on the Corrosion of Boiler Tubes and Superheaters.—At 2.30.—I. G. Slater and T. H. Turner: The Hardness of Carbon Steels at High Temperatures.—A. R. Page: The Hardening and Tempering of High Speed Steel.—A. E. Cameron and G. B. Waterhouse: The Effects of Arsenic on Steel.—E. D. Campbell and H. W. Mohr: Specific Resistance and Thermoelectro-motive Potential of some Steels differing in Carbon Content.—R. H. Greaves and J. A. Jones: The Ratio of the Tensile Strength of Steel to the Brinell Hardness Number.—H. O'Neill: Deformation Lines in Large and Small Crystals of Ferrite.—A. Osawa: The Relation between Space-Lattice Constant and Density of Iron-Nickel Alloys.—T. E. Rooney and L. M. Clark: The Estimation of Phosphorus in Steels containing Tungsten.

Royal Society of Medicine (Laryngology Section), at 10.30 a.m.—Clinical Meeting.

Philological Society (at University College), at 5.—C. T. Onions: Dictionary Evening.

Royal Society of Medicine (Otology Section), in afternoon.

Geologists' Association (at University College), at 7.30.—Prof. S. H. Reynolds: A Geological Tour in South and East Africa (Lecture).

Royal Institution of Great Britain, at 9.—Prof. J. Garstang: Researches in Palestine.

SATURDAY, June 5.

Royal Society of Medicine (Otology Section), in morning.

Royal Institution of Great Britain, at 3.—Sir Walford Davies: The Triad and the Perfect Fourth; their Uses from Hucbald to the Present Day. (With Musical Illustrations.)

PUBLIC LECTURES.

MONDAY, May 31.

London School of Economics, at 5.—Prof. T. H. Pear: Fitness for Work. (Succeeding Lectures on June 1 and 2.)

Imperial College (Royal School of Mines), at 5.15.—Prof. L. Denoel: Tubbing Deep Shafts, and Subsidence. (Succeeding Lectures on June 1, 2, and 3.)—Sir T. W. Edgeworth David: Past Ice Ages of the World and their Control of Animal and Plant Life, with special reference to the Australian Evidence. (Succeeding Lecture on June 7.)

TUESDAY, June 1.

Gresham College (Basinghall Street), at 6.—Sir A. Walford Davies: Music. (Succeeding Lectures on June 2, 3, and 4.)

THURSDAY, June 3.

Chelsea Physic Garden (Swan Walk, Chelsea), at 5.—Prof. J. McLean Thompson: The Plant as an Engineer. (Chadwick Lecture.)

CONFERENCES.

SATURDAY, May 29.

Association of Women Science Teachers (at Northampton School for Girls), at 12.30.

June 1 and 2.

Réunion Neurologique (in Paris).

SATURDAY, JUNE 5, 1926.

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Recruitment for Indian Services.

THE structure of dyarchy originated by the Government of India Act 1919 was carried up another story by Statutory Rules and Orders, 1924, Nos. 354 and 355, issued by the India Office. By those Orders the control of the servants of a local government was put in the hands of the local government up to and including the power of dismissal "for good and sufficient reason." The local government was thus put in a position to secure due diligence on the part of its servants. At the same time, for the protection of the servant from victimisation, these Orders prescribed appropriate inquiry before the infliction of any punishment and set up a suitable system of appeal. The Government of India is the most usual appeal body, and it is interesting to note that special machinery for dealing with such appeals has recently come into being by the appointment of the chairman and other members of the Public Service Commission.

The control of existing servants being in the hands of the local government, it only remained to transfer to the local government the power of making new appointments. This is done by Statutory Rules and Orders 1926, Nos. 390 and 391, recently issued.

Within certain reasonable and necessary restrictions, these Orders give the local government a free hand as to method of recruitment. In this the Orders go beyond the recommendation of the Lee Commission, and rightly. The Lee Commission recommended that in any recruitment by a local government the Public Service Commission should determine "the standards of qualification and the methods of examination." In an article in our issue of July 12, 1924, entitled "Europeans in the Indian Services," we pointed out that that recommendation violated the principle of provincial autonomy, and it is very fortunate for the future of dyarchy that the new Orders make the local control of the transferred services effective by transferring also in full measure the power to appoint and control the government servants engaged in the administration of these services.

In one point only do the Orders show any distrust of dyarchy. The local government is prohibited from lowering the standard of admission without the previous sanction of the Governor-General in Council. It is not clear why it should be suggested that any local government would have a desire to lower the standard. It is true that in India, as in Great Britain, there are always 'people of influence' going about trying to thrust their incompetent relatives into 'soft jobs,' but surely the local government of a governor's province is sufficiently strong to deal with these people without this particular piece of support. This lack of trust is a universal characteristic of our nation; each of us is perfectly convinced of his own impeccable honesty, but at the same time considers it necessary that his neighbour's honesty should be safeguarded.

This, however, is the only blemish, and it is a slight one. For the rest, the local government is given all the freedom a reasonable local government could ask. It is free to recruit in any manner it pleases, so long as it does so by means of a competitive examination or on the advice of a permanent board of selection set up by itself.

At the same time, the position of an existing servant is safeguarded by the condition that any appointment that would adversely affect him requires the previous sanction of the Governor-General in Council. This very effective safeguard, along with the Orders regulating dismissal, should completely allay the fears which the Indian civil servant has sometimes felt as to the security of his position.

These fears have never been shown by the young men at the British universities who furnish the recruits. The true state of affairs is masked by the fact that at the present time the London competition selects fewer Europeans and more Indians than in pre-War days. Because of this, people jump to the conclusion that our universities are no longer prepared to send their best to India. That is wrong. They send their best to the competition as much as ever they did. The study of the university records of the European Indian civil servants recruited now and before the War shows the standard of the present-day entrant to be fully as high as that of the pre-War entrant. The true explanation lies not in the deterioration of the European condidates, but in the improvement of the Indian candidates.

Scott's Polar Journey and the Weather.

Scott's Polar Journey and the Weather: being the Halley Lecture delivered on May 17, 1923. By Dr. G. C. Simpson. Pp. 31. (Oxford: Clarendon Press; London: Oxford University Press, 1926.) 2*s.* 6*d.* net.

IT was natural for Dr. Simpson to choose the subject of Antarctic weather for his Halley Lecture, 1923, in view of the important contributions he has himself made to our knowledge of Antarctic meteorology. Dr. Simpson commences with a lucid exposition of the chief meteorological features, with particular reference to the relation between radiation and air temperature, to the formation in the atmosphere of inverted temperature gradients when the sun is low or below the horizon, to the blizzards which disperse the inverted temperature gradients and thus raise the surface temperature, and to the effect of these on sledging conditions, including the friction on sledge runners. He then reviews the main vicissitudes experienced by Scott on his journey to and from the South Pole, and discusses the importance of the weather in contributing to the disaster which finally overtook the party.

The serious blizzard experienced by the outward-bound party in an unfavourable position at the foot of the Beardmore Glacier delayed them, not only during the time they were laid up, but also on the lower reaches of the glacier, the surface of which became covered with soft snow in which the sledges sank to the cross pieces. This delay was, however, partly offset by bridging of the crevasses with snow. Followed the ascent to the 9000 ft. plateau and the traverse to the Pole, the disappointment of finding that Amundsen had forestalled the party, and the return to the head of the glacier. The effort of sledge-hauling at this altitude in a mean temperature (January) of −19° F. was undoubtedly tremendous, and the party naturally looked forward to a rise in temperature on descent of the glacier. The temperature did rise, only to fall again before the bottom was reached, and to fall still further as the party, now reduced to four, pushed northwards along the Ross Barrier. At this stage of the journey, Scott met generally light northerly winds, insufficient to blow away the softer surface snow, while the favouring southerly winds for which they prayed were infrequent and not of sufficient force to cause the thorough mixing of the air which would have raised the temperature and improved the surface. These conditions lasted until Oates made the supreme sacrifice, the party falling always further and further behind their time table. Finally, only eleven miles from One Ton Depôt and plenty, the blizzard came, but a blizzard of such strength as to render travel impossible and of such duration (at least ten days) as to cause the final catastrophe. These points are discussed by Simpson in detail and in graphic language.

Scott himself maintained that his arrangements were adequate, and that no one in the world would have expected such conditions so early in the autumn. In his message to the public, he says: "Our wreck is certainly due to this sudden advent of severe weather which does not seem to have any satisfactory cause. I do not think human beings ever came through such a month as we have come through. . . ." Dr. Simpson makes it clear that conditions were unusual, not indeed in the occurrence of such low temperatures but in the duration of the cold period unrelieved by blizzards. Herein lay the unforeseen element. Though the onset of the very severe blizzard on March 19 was the actual cause of the disaster, it was, tragically, the absence of blizzards and the consequent intense cold for some time previous to this date which rendered the disaster not only possible, but even probable.

Biology and Human Life.

(1) *Life and Evolution: an Introduction to General Biology.* By Prof. S. J. Holmes. Pp. v+449. (New York: Harcourt, Brace and Co., Inc., 1926.) 3.50 dollars.

(2) *I Believe in God and Evolution.* By Prof. William W. Keen. Fourth edition revised. Pp. 109. (Philadelphia and London: J. B. Lippincott Co., 1925.) 5*s.* net.

(3) *Plain Speaking.* By the Rev. T. R. R. Stebbing. Pp. 218. (London: T. Fisher Unwin, Ltd., 1926.) 7*s.* 6*d.* net.

(4) *Evolution and Creation.* By Sir Oliver Lodge. Pp. 164. (London: Hodder and Stoughton, Ltd., 1926.) 3*s.* 6*d.* net.

(5) *In Search of Reality.* 1: *Organic Evolution.* By J. E. Williams. Pp. 256. (London: Gerald Duckworth and Co., Ltd., 1925.) 7*s.* 6*d.* net.

(6) *The Growth of Biology: Zoology from Aristotle to Cuvier, Botany from Theophrastus to Hofmeister, Physiology from Harvey to Claude Bernard.* By the late William A. Locy. Pp. xiv+481. (New York: Henry Holt and Co., 1925.) 4 dollars.

(1) AS Prof. Holmes points out in the preface to his volume, biology has during the last half-century exerted a profound influence upon human thought and human action, particularly through the theory of evolution and through modern views on the relation between heredity and environment. No one can lay claim to a liberal education unless he has made himself acquainted with at least the rudiments of the science. Prof. Holmes has made a bold and, on the whole, a successful attempt to cover the whole field of modern biology in such a way that his book can be read with interest and profit not only by the elementary student but also by the general reader. The treatment is competent, comprehensive and clear, and the book is eminently readable. With an eye presumably on recent developments in the United States, the author has devoted a good deal of space to the evidence for organic evolution. The problems of development and heredity are dealt with clearly and skilfully, and the practical bearing of our modern knowledge is brought out in a final chapter entitled, somewhat grimly, "The Eugenic Predicament." Our only criticism of the book is that the illustrations are, on the whole, rather poor and imperfectly reproduced.

(2) Dr. Keen's little book is one of the most effective contributions we have seen to the Fundamentalist controversy, and it is not surprising that several editions of it have been called for during the last three years. Dr. Keen is a distinguished surgeon who has seen in his own lifetime the rise of the Darwinian theory and the final acceptance by men of science and by all intelligent laymen of the doctrine of evolution. Throughout it all he has retained a firm belief in Christianity, and he finds no difficulty in harmonising his religious beliefs with a full acceptance of the theory of descent. This gives special point to his judgment of the Fundamentalist outbreak.

> "The recrudescence of the warfare over Evolution, which for many years had subsided and almost disappeared, except sporadically, is a strange and surely only a passing phenomenon. The illogical and futile attacks upon science by some of the miscalled Fundamentalists, and an illogical and even absurd attempt to prove that the Bible contains and anticipated the discoveries of modern science, are doing immense harm to religion. There is serious danger, if present tendencies triumph, that intelligent people—those who eventually mold the thought of the world—will be alienated from the Church and finally driven from it" (p. 18).

There is also a danger, as events have shown, that the transference of political power to a half-educated democracy may tend to repress clear and honest thinking. There is need, therefore, for the biologist to present the case for evolution in a simple and convincing way.

This Dr. Keen succeeds in doing, in an original and effective manner. Believing that facts carry more weight with ordinary people than arguments, however logical and clearly presented, he has given in a series of short and incisive chapters a plain statement of specific facts, most of them drawn from his own personal experience as a surgeon and anatomist, facts which, to his mind, "absolutely demonstrate the solidarity of animal life, more especially in the case of the vertebrates, such as fish, birds, other mammals and man, the highest mammal." He discusses, for example, the homologies of the vertebrate skeleton, the extraordinary similarity of the internal ear throughout the vertebrate series, the similar effects of the endocrine secretions, the analogies of development, and so on. The instances are not new, but they are vividly presented and rammed home with the weight of personal experience and conviction. There are three excellent little plates.

(3) In "Plain Speaking" we have a collection of essays, of very diverse dates, from the pen of another veteran, the Rev. T. R. R. Stebbing. In one he discourses delightfully on the group he has made peculiarly his own, the Crustacea; others deal with teleology, thaumaturgy in the Bible, miracles, the origin of language, wolves and wild boars in France. A mixed bag, certainly, but particularly well written and readable.

Of special interest in the present connexion are the autobiographical details which are vouchsafed in

"An Address on receiving the Medal of the Linnean Society." The author took holy orders in the year 1858 and was plunged straightway into the violent controversies that attended the birth of Darwinism. Being young and enthusiastic and fond of a scrap, he joined in the fray. What followed is best given in his own words:

> "I approached the reading of Charles Darwin's 'Origin of Species' with an easy confidence that I should be able to smash up his heresy and others like it. Instead of which I became an ardent convert, and very soon went on to deliver lectures and preach sermons, harping continually on the new views. These expressions of opinion were, it appeared, very agreeable to those who agreed with them, but very annoying and distasteful to the others." (p. 10).

One or two papers of this kind written in the 'seventies are here reproduced. It required a good deal more courage then than now for a parson to come boldly out on the side of evolution.

(4) Sir Oliver Lodge's thesis is that "there is no essential opposition between Creation and Evolution. One is the method of the other." His book is frankly popular, and makes little demand on the reader's intelligence. Sir Oliver is, as one would expect, interesting and suggestive on cosmical evolution, but not quite so good on the evolution of living things, though his discussion of the essential characteristics of life (pp. 118-119) is sound and penetrating. The spirit of Victorian optimism permeates the book.

(5) Mr. Williams' essay in search of truth deserves more serious consideration. He also is concerned with the reconciliation of science and religion, and sets out to inquire how two cardinal beliefs of orthodox religion fare at the hands of science—the belief in human survival and the freedom of the will. Both are denied by the materialistic determinism which is orthodox in science. Mr. Williams justly claims that the decision in these matters is too important to be accepted second-hand, and has set himself the task of examining the evidence for himself in order to come to a personal and considered judgment. The present volume gives us only the first fruits of his inquiry. He writes:

> "Although the real issues outlined above must, no doubt, be fought out in the psychological arena, since the basic problems—those of individual immortality and responsibility—relate to spiritual and psychic rather than to physical processes, the preliminary battle-ground undoubtedly lies in the realm of biology, in the theories of heredity and organic evolution. Before it is possible to consider the infinitely complex problems of human and animal behaviour in their relation to immortality and spiritual reality, it is necessary to come to some conclusion upon the much more simple, though still intensely difficult, problems of physiological development" (p. 22).

Accordingly, Mr. Williams states and discusses the modern views on development, heredity and evolution, and builds up from them an ingenious and highly speculative theory, based on Brailsford Robertson's autocatalyst theory, J. T. Cunningham's views on hormones and heredity, and the late William Bateson's suggestion in 1914 that perhaps after all differentiation has come about by the progressive unpacking of an original complexity. Mr. Williams has read and mastered his literature in a very competent manner, and his theory will be of interest to those who think that a mechanistic explanation of heredity and evolution is still a possibility.

It is not clear just how far Mr. Williams believes in his own theory, for he tells us at the end of his book that he has deliberately pushed some modern lines of thought far beyond the limits sanctioned by their authors, into the realms of pure speculation, in the effort to see how far physico-chemical explanations can possibly carry us. He concludes by asserting that the most important factor in change is the behaviour of the animal itself, and that "the true origin of physiological evolution appears to lie within the complex factors which determine animal behaviour." Having thus whetted our appetite, Mr. Williams refers us to a second volume, which we shall await with interest.

(6) Dr. William Locy's posthumous book takes us into the calmer realms of history, and shows us something of the way in which biological discoveries have been made and new theories evolved. Special attention is given to the human note, portraits and biographical details being supplied with a lavish hand. The illustrations throughout are interesting and well chosen, particularly those taken from the old Herbals and the works of the early anatomists and microscopists. Perhaps too much attention is paid to personalities and individual discoveries—one certainly gets no very clear view of the general growth of ideas. For this defect the author's method of arrangement is partly responsible, for he is too much inclined to follow up the various lines of research singly and in isolation from progress in other directions—hence a certain disjointedness in the treatment.

One might complain, too, that some periods are treated in far too great detail compared with others of greater importance, that in particular too much space is given to the late Middle Ages, while the nineteenth century is treated rather cursorily. But it is true that the book does not profess to bring the story in any detail past about the middle of last century, and one can see that Locy was keenly interested in the early workers; his elaboration of detail about them has been a labour of love. There are other points which lend themselves to criticism, particularly his very low estimate of Aristotle's theory of development as given in the "De generatione animalium," but these need not obscure the real merit and interest of the book. Although interest in the history of biological science has of late years greatly increased in Great Britain, thanks in large measure to Dr. Charles Singer, more attention still should be paid to it for its educative value. For this reason Dr. Locy's book should find a place in every biological library. It is a pity he did not live to write the volume which he contemplated on the history of evolution-theory and genetics.

E. S. R.

Sexual Physiology.

An Introduction to Sexual Physiology: for Biological, Medical and Agricultural Students. By F. H. A. Marshall. Pp. xii+167. (London: Longmans, Green and Co., Ltd., 1925.) 7*s*. 6*d*. net.

IT is a relatively simple matter to interpret a science in a popular way to an audience that is entirely ignorant of it: it is a far more difficult thing to simplify the complicated for those who, keenly interested, strain eagerly at the threshold of their professional careers, since if great care is necessary in the selection of one's subject matter, still greater must be taken in the method of its presentation. Whatever else may be taught, it is imperative that the student of science shall, from his initiation, be made aware of what science is and of the discipline that must be self-imposed by those who serve. We may be sure that not all those who insistently urged Dr. Marshall to write this book, knowing how great was the need for it, recognised that they were setting him so difficult a task. He was to take his standard work on "The Physiology of Reproduction," refine it, and make it palatable to such as possess but a rudimentary knowledge of biology, to students of agriculture, medicine, and of pure science.

This small and remarkably inexpensive book that Dr. Marshall has written adequately presents that essential minimum of information relating to the subject of sexual physiology which ought to be possessed in common by every biologist, be he pure biologist, agriculturist, medical, or sociologist. In our opinion, the apprentice of pure biology cannot read the author's larger work too early in his career and should not be encouraged to begin with the volume under review. Medical and agricultural students will be well advised to use this book as a supplement to the usual text-book of general physiology. Those who are, or who intend to be, active in the field of sociology should be compelled to read and digest it before being allowed to enunciate doctrines or remodel laws concerning the social aspects of human reproduction. The book will be largely used. We therefore submit to the author certain criticisms in order that he may consider them against the time when the call will come for the second edition.

Chapters i.-v., dealing briefly with the anatomy and physiology of the reproductive system, the sexual cycle, pregnancy, parturition, the puerperium, and lactation, adequately present the essentials of these subjects. Certain alterations can be suggested. In the illustration of the sperms of different species it is a mistake to show two figures from the frog and the boar, differing in size and form, unless some explanation of this difference is appended. The alert student will imagine that sperm dimorphism, of which he will read later, is of the magnitude suggested by this illustration. Instead of stating that in the bee the female "gives rise to two kinds of eggs, one kind developing without fertilisation and giving rise to drones or males while the eggs of the other kind, which are fertilised by stored-up sperm, develop into workers and queen, both of which are females," would it not be better to say that if an egg is fertilised it develops into a female, a queen or a worker; if it is not fertilised, it gives rise to a male, either sexually functional or else a drone? The statement that "in certain hermaphrodite species the two sorts of sex cells are produced simultaneously by the same individuals, but in these the spermatozoa and ova are found at different seasons, the individual animals sometimes functioning as males and sometimes as females," is an instance of simplification that ends in profound obscurity. Finally, we think that the author is mistaken in his occasional choice of the teleological form of presentation. Those of his fellow-teachers who rigorously avoid this all too simple method of teaching already find it sufficiently difficult to break the student of this habit of thought.

Chapter vi., on internal secretion, is clear, simple, and necessarily dogmatic. The author is misled by his authorities when he states that following ovariotomy in the hen the erectile structures about the head remain unaffected. In point of fact, following ovariotomy, if the right gonad does not become active, the head furnishings undergo a very marked diminution in size.

In Chapter vii., on heredity and sex, the author enters the less familiar field of the genetical aspects of sexual physiology. In order to make the survey of the subject complete, this was necessary; but the result is distinctly unfortunate, for this chapter is marked with inaccuracies and much of it is extremely obscure. The plea of simplification cannot excuse the repeated teaching that the gametes or the chromosomes carry the hereditary characters. The sex-chromosomes do not differ from the autosomes in their behaviour. It is incorrect to state that "the Y-chromosome may seem to be wanting altogether so that it was thought formerly that the male had one fewer chromosome than the female." It is an established fact that in many forms there is in one sex one unpaired sex-chromosome. The attempt to explain in simple terms and briefly Goldschmidt's Time Law of Intersexuality is not successful.

Chapter viii., on fertility, will provoke the student to serious thought, being rich in philosophy and admirably written. The only statement which we think is unnecessarily obscure is that "in certain breeds of fowls Pearl has found further that one of the factors for increased egg production is sex-linked, being present in the cock only and transmitted by him to the next generation of hens." The chapter and the book ends with an apt quotation from Keynes' article on "Reconstruction in Europe," and the student reading this will not fail to realise how far he has travelled since first he opened this excellent work.

F. A. E. Crew.

A Woman of Science.

Hertha Ayrton, 1854–1923: a Memoir. By Evelyn Sharp. Pp. xv + 304 + 5 plates. (London: Edward Arnold and Co., 1926.) 15s. net.

In her memoir of Mrs. Ayrton, Miss Evelyn Sharp has given an excellent account of the life and work of a remarkable woman, and has appropriately dedicated the book to Madame Curie as a co-worker in science and democracy for whom Mrs. Ayrton had a high regard.

The volume of some 300 pages is divided into twenty chapters and has five illustrations. It is well printed and, so far as the reviewer has been able to check, its contents are very accurate. Only two slight errors have been noticed, namely, on pp. 140 and 303 where "Morley" appears instead of "Mordey," and on p. 229 (3 lines from bottom) where the word "After" should read "Before."

From the book it appears that in early childhood, Phoebe Sarah Marks (as she then was) showed marked intelligence and originality, and displayed unusual ability and resource. These facts were noticed by her well-to-do and talented relatives, the Hartogs, who, in consequence, gave her an education her parents were unable to afford. Miss Marks' girlhood was nevertheless a strenuous one, and when barely sixteen years of age she took a post as governess in a private family so that she might help to support her widowed mother and invalid sister. Through her relatives she was introduced to many persons of influence and repute, several of whom aided Miss Marks in her ambition to enter Girton College, which had then been recently founded for the higher education of women. Although her examination records at Girton were not brilliant, her supporters never lost confidence in their protégé, and this confidence was amply justified by her subsequent achievements.

Before proceeding to Girton, Miss Marks took great interest in physics and mechanics, and helped one of her boy-pupils to make a model steam engine. Further evidence of the scientific bent of her mind was given by the invention of a "sphygnometer," whilst at Girton, and of a "line divider" shortly after she came down; the latter instrument was put on the market by Messrs. Stanley, of Great Turnstile, Holborn, and was described before the Physical Society of London.

Short accounts of Miss Marks' first meeting with Prof. Ayrton in 1882 and of their marriage in 1885 are given in Chapters vii. and ix., whilst Chapters x. and xi. describe Mrs. Ayrton's classical researches on the electric arc, and her admission to the Institution of Electrical Engineers. The origin and progress of Mrs. Ayrton's painstaking work on sand ripples are then described in some detail, and in a manner creditable to both worker and biographer. These researches led to the award of the Hughes Medal (for original discovery in physical science) by the Royal Society in 1906, thus giving further confirmation of her success in science, which had previously been acknowledged by her election as member of the Institution of Electrical Engineers.

A considerable portion of Miss Sharp's book is devoted to the part Mrs. Ayrton took in the Suffragist movement in Great Britain, in which both author and subject were keenly interested. Mrs. Ayrton's many activities in this campaign must have interfered seriously with her purely scientific work, but in spite of this, she managed to carry out several investigations. She extended her studies on sand ripples and associated phenomena, and developed a new type of carbon for producing steady arcs for cinemas and searchlights.

The closing chapters of the book deal mainly with the "Ayrton Anti-Gas Fan," invented shortly after the first gas attack in the War. This invention was a development of Mrs. Ayrton's sand ripple studies and of the vortices which accompany the production of ripples. Immense difficulties were experienced in getting the authorities to give the fan a fair trial; this was largely due, in the inventor's opinion, to its extreme simplicity. Even when the fan was adopted, it was sent to the front in insufficient numbers and without proper instructions for its use.

In conclusion, one may say that this book is an admirable record of the life and work of a woman distinguished alike as scientist, suffragist, and humanitarian.

T. M.

The Yorkshire and Nottinghamshire Coalfield.

Memoirs of the Geological Survey, England and Wales. The Concealed Coalfield of Yorkshire and Nottinghamshire. By G. V. Wilson. Second edition. Pp. vi+283+5 plates. (London: H.M. Stationery Office; Southampton: Ordnance Survey Office, 1926.) 8*s.* net.

THE second edition of the memoir on the Concealed Coalfield of Yorkshire and Nottinghamshire has just been issued by the Geological Survey of Great Britain. The first edition by Dr. Walcot Gibson was published so far back as 1913; at that date the development of this important coal area had only just commenced and our knowledge of it was relatively slight. Since that date numerous boreholes have been put down, a good many shafts sunk, and not a few important collieries have been developed and are now working and raising coal, and in consequence a vast number of data concerning the geology of this area has been accumulated. The present volume, more than double the size of the first one, embodies the results of the knowledge thus acquired.

The memoir appears at a very fortunate moment when this coalfield is undergoing intensive development, and, as may be gathered from the recent report of the Coal Commission, it is to-day one of the few remunerative coal-producing districts in Great Britain and bears every indication that its future will prove to be of great national importance. The present volume will be of the utmost use, and possibly no portion of the report will be more carefully studied than Chap. iv., which deals with the configuration, structure and limits of the coal basin. In this respect the eastern boundary of the basin is the one on which the greatest amount of discussion centres, and it is a point which will seriously affect the working of the entire coalfield. Thus the first report of the Royal Commission on Mining Subsidence, which dealt particularly with the area described in this memoir, which the Commission has spoken of as the Doncaster Area, points out that an effective scheme for dealing with the flooding due to colliery subsidence must be governed largely by the position of the eastern boundary of the coalfield, as to which geologists are still in doubt. The present report shows that this doubt still subsists. The first report issued in 1871 placed the boundary of the concealed coalfield 2 or 3 miles east of the Trent; the final report of the Royal Commission on Coal Supplies of 1905 adopts the view of Prof. P. F. Kendall, which places the boundary 20 to 30 miles east of the Trent. The present report shows that in all probability both views are right, and that in the neighbourhood of Newark the limit assigned in the older report is probably correct, whilst to the east of Lincoln the "line approximates more nearly to that suggested by Professor Kendall."

The volume before us contains a mass of information; it discusses the various formations in detail, then proceeds as stated to consider the configuration of the coal basin, and finally contains a large number of valuable records of sections derived from shaft sinkings and borings. The appearance of this volume at the present moment will be exceedingly welcome to all interested in this important coalfield.

Our Bookshelf.

Ergebnisse der Biologie. Herausgegeben von K. v. Frisch, R. Goldschmidt, W. Ruhland, H. Winterstein. Erster Band. Pp. viii+670. (Berlin: Julius Springer, 1926.) 36 gold marks.

THE vast and ever-increasing flood of indiscriminate publication—including observations of every degree of importance and trustworthiness—which at present constitutes a real menace to the ordered progress of biological science, brings in its train the need of organised publication of 'potted extracts' of contemporary biological literature. An admirable publication of this kind summarising modern advances in our knowledge of the functional as opposed to the anatomical side of zoological science was Winterstein's great handbook of comparative physiology, which, commencing to appear some fifteen years ago, has recently reached completion. The new "Ergebnisse der Biologie" may be regarded as a continuation of Winterstein's handbook, to deal with contemporary literature in the subject as it appears. The scope of the new periodical is, however, rather wider, as its purview will cover comparative physiology in the broadest sense, including such subjects as plant physiology, experimental embryology, animal psychology, and the study of heredity.

That the work will be well done is guaranteed by the names of the distinguished quartet of editors. The opening volume deals with the comparative physiology of the skin of vertebrates (Biedermann), the ascent of sap in plants (Bachmann), the relations of the plant-cell to chemical salts (Kaho), ammonia, nitrate and nitrite as sources of nitrogen for the higher plants (Prianischnikow), the social psychology of birds (Katz), and the migration of birds (Wachs). The contemplation of these titles indicates how wide is the field over which the subject matter is distributed, but it also indicates clearly what will be the future of the periodical—not a systematic survey of all the literature appearing within its boundaries, but rather a series of summaries of isolated and restricted portions of the subject by competent specialists. Such a system, although lacking completeness, is probably on the whole of greater real use to students. Thus in the volume under review the first article is in effect an excellent and well-illustrated text-book of 342 pages upon its subject.

The new periodical will have to be added to the libraries of all university schools of biology.

Practical Coal Production. Preliminaries of Coal Mining: Prospecting, Explosives, Development, Drainage, Ventilation. Compiled by Frank H. Kneeland. Pp. vii+419. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 15*s.* net.

THIS little work contains a brief description of American coal-mining practice in certain branches of the industry. There are six chapters, the contents of which are: (1) Prospecting, (2) explosives and blasting, (3) development operations, drifting, tunnelling, shaft sinking, (4) planning, projection, development, (5) drainage, (6) ventilation and ventilation equipment. When it is seen that the whole work only comprises 413 pages, it will be obvious enough that no one of these subjects can have received anything like adequate treatment, and a perusal of the work leaves on one's mind the impression that the information conveyed is of a decidedly 'scrappy' nature. To prevent misconception, it may be pointed out that Chap. iv., which is headed "Planning, Projection, Development," refers entirely to the lay-out of the surface and does not attempt to discuss the infinitely more important question of the lay-out of the underground workings.

The work deals entirely with American practice, and in that respect will afford little or no assistance to mining engineers in Great Britain. For example, in dealing with shaft sinking, the author states that circular, elliptical and other forms of shafts are used, but he practically confines his attention to the rectangular shaft; this is the only form that he considers when discussing the size of shafts, as indicated by the following statement: "Main hoisting shafts vary greatly in size, some being as small as 5 × 10 ft., whilst others are as large as 15 × 60 ft. in the clear." He makes no attempt at discussing the relative advantages or disadvantages of the two types of shaft, but, in conformity with general American practice, takes the rectangular type more or less for granted.

The book throughout contains many little bits of useful information, though occasionally we find a mass of detail which is scarcely necessary, as, for example, the elaborate instructions for priming and attaching the fuse to a blasting cartridge. Such information is quite unnecessary for the practical mining engineer, and is in any case out of place in a book, as it is always far better and more rapidly learnt by actual experience; it is, in fact, one of the weak points of the work that it appears in places to be addressed to the beginner at the very outset of his career, and in others to be written for the experienced mining engineer.

Telephone Communication Systems. By Prof. Royce Gerald Kloeffler. (Engineering Science Series.) Pp. vii+284. (New York: The Macmillan Co., 1925.) 17*s.* net.

THE author gives a brief account of the whole field of telephony, laying stress on the latest developments of the art. In the United States there are more than 15 millions of telephones in use and thousands of miles are bridged between many pairs of them. Sound waves would take four hours to travel through the air from New York to San Francisco. With the help of electricity, however, they go over the transcontinental line in about the fiftieth of a second. By General Squier's method the same wire can also, theoretically at least, carry twenty-four simultaneous telephone messages, although in practice arrangements are seldom made to carry more then five distinct messages simultaneously. The development of the thermionic valve repeater has placed long-distance telephony on a sound engineering basis. The invention of electric filters which only allow waves of definite frequencies to pass through them led to multiplex telephony.

Heaviside's and Pupin's loaded cables are still used for submarine work and in long-distance land lines. In the latter case, however, valve repeaters are now largely used. It is pointed out that appreciable reflection losses occur when two lines having different electric constants are joined together. These losses are quite distinct from attenuation losses. We are glad to see that a sharp distinction is made between electrostatic and electromagnetic interference. The former is particularly troublesome on telephone circuits. When there are high-tension circuits in the neighbourhood, the electrostatic induction sometimes makes the potential difference between the telephone wire and the earth so great that there is a risk of a serious shock. In the concluding chapter the elementary principles of radio telephony are clearly explained. The book can be recommended to electrical engineering students who desire to get a general insight into the theory and practice of telephony.

Elementary Electrical Engineering: a Lecture and Laboratory Course intended for Students preparing for the First National Certificate Examination in Electrical Engineering. By Prof. O. R. Randall. (Technical School Series.) Pp. vi+233. (London: Sir Isaac Pitman and Sons, Ltd., 1926.) 5*s.* net.

THE combination of lecture work with laboratory experiments given in this book is good, but we are doubtful as to the educational value of some of the mathematical demonstrations given. For example, after saying that the average and effective values of the ordinate of a sine wave are $2/\pi$ and $1/\sqrt{2}$ times its maximum value respectively, it is stated that these relations may easily be demonstrated by drawing the curves and finding their mean heights. The industrious student, therefore, is expected to draw the sine curve, and the curve the ordinates of which are the squares of the sine, and get their mean heights. He doubtless knows that the results will come out within one or two per cent. of the numerical values of the mathematical expressions given above, but he will probably prefer to take the easier course of accepting the author's word that they are correct. We are told that if the three vectors representing the currents in a three-phase system are added together they form a closed triangle and their resultant is therefore zero. We think that this is looking at the matter the wrong way round. Since the algebraical sum of the three currents is by Kirchhoff's law always zero, their resultant, that is, the effective value of their sum, must of necessity be zero, and therefore the three vectors form a triangle. This is true whatever the shape of the current waves may be. We fully recognise that the mathematical knowledge of many of the candidates preparing for the national certificate is limited, but we think that some of the proofs given are too sketchy.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. Emil Abderhalden. Lieferung 182. Abt. 9: *Methoden zur Erforschung der Leistungen des tierischen Organismus*, Teil 1, 2 Hälfte, Heft 1. *Spezielle Methoden: Tierhaltung und Tierzüchtung. Züchtung von wirbellosen Tieren.* Pp. 214. (Berlin und Wien: Urban und Schwarzenberg, 1925.) 9·60 gold marks.

THE present instalment of the encyclopædic work edited by Prof. Abderhalden is concerned with the keeping and rearing of animals for scientific observations. Dr. Kammerer discusses the subject in so far as Reptilia and Amphibia are concerned, and his experimental researches are familiar to all zoologists. This article is followed by one by Dr. Heitkertinger on the general apparatus and technique used in rearing insects. There are also separate articles by different specialists dealing with particular methods applicable to the Apterygota, the "Amphibiotica," Orthoptera, Corrodentia and Rhynchota. These different sections are something more than guides to the technique concerned, since the life-histories and behaviour of representatives of the various orders are discussed in detail, with numerous bibliographic references. The most extensive contribution is that by Dr. F. Zacher on the Orthoptera: this might almost be regarded as a complete synopsis of the biology and economy of that group. The remainder of the Insecta is to be dealt with in future issues. A. D. I.

Cellulose Ester Varnishes. By F. Sproxton. (Oil and Colour Chemistry Monographs.) Pp. 178. (London: Ernest Benn, Ltd., 1925.) 15*s.* net.

THIS volume of the series of oil and colour chemistry monographs is an excellent statement of the properties of the cellulose esters used for varnishes and of the finished products prepared therefrom. Particular attention has been given to those physical properties, viscosity, solubility, swelling, dispersion, and so on, which are important for the practical utilisation of cellulose esters in varnish making. In fact, pp. 58-92 constitute one of the best and most readable accounts of physical behaviour of cellulose esters available in so short a space. The nature and properties of the solvents of cellulose esters and the reasons for using them are adequately dealt with. Chapters dealing with the manufacture, application, and examination of cellulose ester varnishes furnish all the information which can reasonably be expected in a volume of this character. The subject matter is presented clearly throughout, and the work may be recommended to all those who desire an accurate statement of the present position of a growing branch of industry.

The Birds of the Riviera: being an Account of the Avifauna of the Côte d'Azur from the Esterel Mountains to the Italian Frontier. By Collingwood Ingram. Pp. xv+155+6 plates. (London: H. F. and G. Witherby, 1926.) 12*s.* 6*d.* net.

MR. COLLINGWOOD INGRAM has produced a book on the birds of the Riviera which will be useful to ornithologists among the many English-speaking visitors to that region. The scope of the work excludes the Italian portion of the littoral, but, on the other hand, it includes the whole of the French department of Alpes Maritimes, a fact which brings many strictly alpine species within its purview. The arrangement is systematic, and the text is not burdened by descriptions of those species which will be familiar to British readers at home and are dealt with in the ordinary text-books upon British birds. In addition to English and scientific names, the French and Niçois equivalents are conveniently given. The illustrations include numerous sketches by the author and a number of plates by well-known artists.

Flora of the Presidency of Madras. By J. S. Gamble. (Published under the Authority of the Secretary of State for India in Council.) Part 7: *Nyctaginaceæ to Euphorbiaceæ.* Pp. 1161-1346. (London: Adlard and Son and West Newman, Ltd., 1925.) 10*s.* net.

A MELANCHOLY interest is attached to this review, since the author of the work under notice died while it was still in the press, though he was able to correct all but the last few sheets of the proofs. It is greatly to be regretted that Mr. Gamble did not live to complete the flora, for he had an unrivalled knowledge of the region and its flora.

Part 7 now issued begins the Monochlamydeæ, and comprises the families according to the Genera Plantarum sequence from Nyctaginaceæ to Euphorbiaceæ with some minor deviations, *e.g.* the Hernandiæ are separated from the Lauraceæ forming the family Hernandiaceæ to include Gyrocarpus. Four new genera, twenty-five new species (mostly first described in the *Kew Bulletin*), and eleven new combinations are included. C. E. C. F.

Die gasanalytische Methodik des dynamischen Stoffwechsels. Von Dr. Wilhelm Klein und Maria Steuber. Pp. 99. (Leipzig: Georg Thieme, 1925.) 5·40 gold marks.

THE authors bring together certain well-known methods of determining metabolism by means of the respiratory exchange. The most space is devoted to a description of the Zwetz-Geppert method, which has not been used in England or America for a good many years. With the exception of the student apparatus of Benedict, which does not give the respiratory quotient, and an inadequate account of Krogh's latest apparatus, no description of any of the numerous variants of portable metabolism apparatus is given. The book contains nothing useful which is not already available in convenient form to English and German readers. The few references to the literature are given with little care.

E. K. R.

Qualitative Inorganic Analysis. By Dr. D. R. Snellgrove and Dr. J. L. White. Pp. xi+281. (London: Methuen and Co., Ltd., 1926.) 7*s.* 6*d.*

THE explanations and practical hints given in this book are more detailed than is usual and will be found of value. The standard is that required in B.Sc. honours examinations. The authors appear to dislike tabular presentation in group separations, but there can be little doubt that this form is more convenient in laboratory work and in recording the results obtained in practical examinations. The book is printed on thick paper and does not remain open easily, both disadvantages in laboratory use.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Dutch Pendulum Observations in the Atlantic and the Pacific.

I AM able to give the following particulars of the proposed pendulum observations in the Atlantic and the Pacific. In compliance with the request of the Geodetic Committee, the Minister of Marine has resolved that H.M. Submarine K XIII, appointed for service in the Dutch East Indies, will make the voyage to Java via the Panama Canal, in order to enable Dr. Vening Meinesz to make pendulum observations in the Atlantic and the Pacific. The main object of this voyage being scientific, the route has been fixed in accordance with the wishes of Dr. Vening Meinesz.

On May 26 the submarine will start from Helder; it will be at Fayal (Azores) July 4-6, and at Las Palmas (Canaries) June 12-16. From there it proceeds to the Porto Rico deep, crossing for the second time the middle Atlantic ridge, and thence by the Mona Passage to Curaçao, where it remains from July 5 until 17. It will be at Colon, July 20-22, and at Panama, July 22-26. In the Pacific it will at first sail westward to reach the deep sea, and then return to the coast; on August 6-12 it will be in Mazatlan and will reach San Francisco, August 20. It starts from there for the crossing of the Pacific on September 2; it will be at Honolulu on September 14-27, at Guam on October 16-28, and at Yap on October 30-November 2. Before reaching Guam it passes the Nero deep (5268 fathoms). From Yap it sails to Manila by the Straits of Surigao, crossing the Manila deep, where the greatest known sea depth (5350 fathoms) has been sounded. It remains at Manila from November 11 until November 17 and sails then for Ambon, where it stays from November 24 until November 29. Via the Banda deep it reaches Bima (Sumbawa), where it remains from December 5 until December 8, and will arrive at Surabaya on December 10 after a voyage of 195 days, 109 of which are sailing days. The whole length of the track is nearly 20,000 miles.

In the light of the experience which Dr. Vening Meinesz has gained of the new pendulum apparatus on his voyage to Port Said (NATURE, April 10, p. 531), some improvements have been made in the workshop of the Meteorological Institute of de Bilt. The suspension apparatus with one axis, to be placed parallel to the keel of the ship, has been replaced by a support with double gimbals in order to avoid the sliding of the pendulums caused by the pitching of the vessel. Probably by this means it will be possible to make observations at a lesser depth below the surface of the sea, and perhaps in favourable circumstances at the surface itself. This modification necessitated the connexion of the recording apparatus with the support; the former is now placed with the slit in a horizontal position above the former. For the guidance of the rays of light a system of prisms has been added.

The accuracy of the observed time signals during this voyage will be increased by the loan from the U.S. Coast and Geodetic Survey, with the consent of the Secretary of Commerce of the United States, of a wireless recording set. Special thanks are due to the Director, Mr. E. Lester Jones; the Assistant Director, Mr. R. L. Faris, and the Chief, Division of Geodesy, Dr. W. Bowie, for their valuable co-operation in this matter.

The time signals to be used will be first those of Bordeaux, then those of Annapolis, and afterwards those of Balboa. The co-operation of the U.S. Naval Observatory at Washington has been obtained for the control of these signals. During the voyage in the Pacific rhythmic time signals will be given by the powerful radio station of Malabar (Java), controlled by the Observatory at Lembang. This will control also the time signals of Manila, which may be used in the western part of the Pacific.

At the request of Commander J. H. L. Luymes, Hydrographer of the Dutch Marine and member of the Geodetic Committee, the Hydrographer of the U.S. Navy sent a set of charts of the Pacific where the most recently obtained sea depths are noted. For the determination of the sea depth during the voyage the submarine will be provided with a sonic depth-finder of the type of the British Admiralty, constructed by Messrs. Hughes and Sons of London, with regard to which the Hydrographer of the British Navy, Captain Douglas, has rendered much valued assistance. With regard to deep soundings, the voyage of the submarine may also give valuable contributions.

I will not digress into a discussion of the advantages that may be derived for science from the observations of Dr. Vening Meinesz. I will but mention that as the track runs for a great part of the length not far from and nearly parallel to the equator, the question whether this is elliptic or not will probably be solved. The observations in general, and especially those near the coasts, as well as those near the edges of and above the great deeps, will be of much interest for the study of isostasy and other geophysical problems concerning the constitution of the earth's crust.

I may perhaps be allowed to express the hope that the example given by the Dutch Navy in the investigation of purely scientific questions will soon be followed by other nations.

J. J. A. MULLER.

Zeist, May 1.

Optical Rotatory Dispersion.

SINCE the publication of Prof. T. M. Lowry's article in NATURE of February 20, 1926, p. 271—an article which, I observed, drew a gentle remonstrance from Prof. Armstrong in the issue of April 17—I have felt that some rejoinder was desirable, but was held back by the fact that adequately to criticise Prof. Lowry's views would require considerably more space than the article itself, since almost every statement made, far from possessing the definiteness which Prof. Lowry attributes to it, is highly controversial, and it usually requires less space to make an assertion than convincingly to refute it. But perhaps I may be allowed to point out that so far back as 1916 (*J.C.S.*, 109, 1211-1216, 1222-1224) I offered a reasoned criticism of most of the views which Prof. Lowry has so industriously advocated in the last few years, and that hitherto Prof. Lowry has not attempted any reply to these criticisms. Incidentally it may be suggested that Prof. Lowry does his thesis some disservice by a policy of aloofness from valid criticism directed against it. It may, of course, be that the criticisms are unanswerable, in which case Prof. Lowry's views require modification.

In addition to the criticisms already made, I would add here one or two more. In the first place, Prof. Lowry's views depend entirely upon some observations of Biot, made many years ago, according to which he found that the rotation dispersion of a mixed solution of oil of terebenthene and oil of lemon was identical with the sum of the dispersions of the same substances separately (*Compt. rend.*, 1836, **2**, 543; see also *Ann. Chim. Phys.*, 1852 [iii], 36, 430). Now the accuracy with which Biot could carry out his observations was very much less than that possible at the present time, which may perhaps be illustrated by the fact that whereas Biot thought that quartz conformed to his simplest law of rotation dispersion, Prof. Lowry himself has shown that a Drude expression of no less than three terms is necessary to represent its behaviour. Further, it has not been shown with modern accuracy, either that the rotation dispersions of terebenthene and oil of lemon conform to Prof. Lowry's definition of simple dispersion, or that when mixed together they conform accurately to his definition of anomalous dispersion. Practically all modern work has demonstrated very clearly the fact, of which Biot was aware, that only in exceedingly few cases, if indeed in any, can one obtain, by mixing together two optically active liquids, purely additive results. It is doubtful, therefore, whether it is even worth while to repeat Biot's experiment.

Again, Prof. Lowry seems to be unduly partial towards the evidence which he adduces in favour of his views. Thus, for example, he says: "Tschugaeff has shown that anomalous rotatory dispersion can be produced by superposing the opposite partial rotations of two radicals in the same molecule, as in *l*-menthyl *d*-camphorsulphonate." This statement is utterly misleading. Tschugaeff found the dispersion of *l*-menthyl *d*-camphorsulphonate to be anomalous, and he *suggested* that this might be due to the superposition of two opposite partial rotations, but he certainly did not *show* that this is actually the case. It suits Prof. Lowry's view, however, to regard Tschugaeff's assumption as equivalent to a demonstration, but he makes no reference to the fact that in *l*-menthyl *d*-camphorsulphonate there are not two asymmetric centres in the molecule, but actually five—and even six if Prof. Lowry's idea of the asymmetry of the carbonyl group be adopted—so that the rotation dispersion of menthyl camphorsulphonate should be a very complex affair if superposition of asymmetric centres in the molecule plays a part in it.

It would easily be possible to extend these remarks.

T. S. PATTERSON.

Organic Chemistry Department,
University of Glasgow,
April 26.

I FIND it difficult to discover what reply Prof. Patterson expects to his courteous letter of April 26. From the two experiments which he cites I gather that he wishes to call in question the general proposition that *anomalous rotatory dispersion in transparent media is due to the superposition of two normal rotations*[1] *of opposite sign*. He has, however, described these two experiments in such a way that it is difficult to believe that either Biot's or Tschugaeff's paper was before him when he wrote his letter. In particular, Biot's synthesis of an anomalous rotatory dispersion, by superposing two normal dispersions of opposite sign (*C.R.*, 1836, **2**, 540), does not depend, as he suggests, on the existence of an additive law of optical rotatory power in mixed liquids, since in the first instance the liquids were not mixed but were contained in two separate tubes, the superposition of rotations being purely optical. A precisely similar result was obtained when the two liquids were mixed, but there are no numerical data in the paper which would justify the assertion that Biot "found that the rotation dispersion of a mixed solution . . . . was identical with the sum of the dispersions of the same substances separately"; nor does my acceptance of the general proposition set out above depend on any such assumption.

In the same way, Tschugaeff's experiment (*Ber.*, 1911, 44, 2023) was not a mere numerical exercise in the summation of optical rotations, but a definite test to find out whether anomalous rotatory dispersion could be produced by "intramolecular superposition" as well as by Biot's process of "extramolecular" superposition. His experiment showed that an alcohol and acid, the opposite rotations of which would have given rise to anomalous dispersion if superposed by either of Biot's methods, also gave rise to anomalous rotatory dispersion when united into a single molecule by the elimination of a molecule of water. This successful synthesis has been generally accepted as evidence of the continued existence of the opposite partial rotations of the two radicals after esterification;[2] and its success does not depend, as Prof. Patterson appears to think, on the accuracy of the law of optical superposition, which Tschugaeff himself regarded as only a "first approximation." Nor is it necessary that the component "normal" rotations in any of these syntheses should conform to the law of "simple rotatory dispersion."

Since, as I have shown (*J.C.S.*, 1925, **127**, 606), there are at least six different ways (mathematical, physical or chemical) in which normal rotatory dispersions may be superposed to produce anomalous rotatory dispersion, there is plenty of room for diverse opinions as to the particular form of superposition which gives rise to this effect in any given case; but I do not think that any useful purpose would be served by a discussion in the columns of NATURE of these applications of a general principle which was established once for all by Biot in 1836.

T. M. LOWRY.

University Chemical Laboratory,
Cambridge, May 1.

Hardness of Copper-Tin Alloys.

IN NATURE of January 23 I described some experiments on the hardness of various materials, the hardness being measured by the pressure which the material can withstand.

Since that time the same test has been applied to many of the metallic elements, and it is intended to form as complete a table as possible of the hardness of those to which this method is applicable.

Some experiments have also been made on the hardness of alloys, and its variation with the relative proportions of the constituent metals.

An example for copper-tin alloys is given in the accompanying diagram (Fig. 1). These alloys exhibit an extraordinary range of hardness passing from 48 tons/inch^2 (pure copper) to about 6 tons/inch^2 (pure tin), but rising to 220 tons/inch^2 when one-third of the volume is tin (speculum metal). The hardness of the latter is about that of rather a low temper spring steel, though the other physical properties of the two are very different.

I found that small quantities (a gram or less) of the required alloys could be conveniently made by melting the proper proportions of the constituents under borax in the closed end of a hard glass tube, using a gas blowpipe with a little oxygen added. If the process is properly carried out, the fused metal becomes embedded in a solid glass globe hanging by a narrow neck to the end of the glass tube On breaking the globe when cold, the alloy is found as a bright and nearly spherical bead.

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[1] A 'normal' rotatory dispersion is defined as one in which α, $d\alpha/d\lambda$, and $d^2\alpha/d\lambda^2$ remain constant in sign throughout the region of transparency. In an 'anomalous' dispersion, changes of sign may occur in all these quantities, giving rise respectively to a reversal of sign, a maximum and an inflexion in the dispersion curve.

[2] The statement which Patterson describes as "utterly misleading" is a close paraphrase of the words used by Tschugaeff himself in describing his experiments in the Faraday Society's general discussion on "Optical Rotatory Power," when he claimed that he had shown "that anomalous dispersion may be produced by the *superposition of the partial rotations produced by two asymmetric complexes within the molecule of an active body*." (*Trans. Faraday Soc.*, 1914, 10, p. 73).

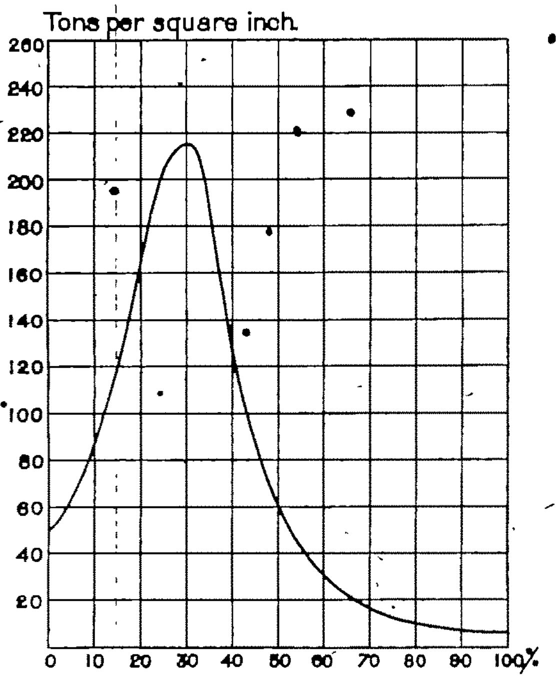

FIG. 1.—Diagram showing the hardness of copper-tin alloy in terms of the volume-percentage of tin The ordinates give the hardness of the alloy in tons per square inch, the abscissæ are the percentages of tin by volume.

The glass remains clear and uncoloured, and it may be assumed, therefore, that there has been no loss by oxidisation. A. MALLOCK.

9 Baring Crescent,
Exeter.

Egyptology in Victorian Dress.

As the reviewer of "Descriptive Sociology" (NATURE, April 24, p. 578) accuses me of misrepresenting the divergent views of chronology, while making an *ex parte* statement himself of the 'demolition' of a view which he dislikes, I trust I may be permitted to outline the facts.

All scholars agreed in accepting what the Egyptians recorded as to the beginning of the history by the first dynasty about 5500 B.C., until Bunsen in 1845 started a truncation of this to 3600 B.C., rejecting the records because of our ignorance of the monuments. Yet the Egyptian view was maintained in Germany until 1884 or later. Since then, most important discoveries of monumental material have led Berlin scholars to go back to 4186 B.C., which is still the date accepted by officials of the Berlin Museum. Further, museum authorities in England, France and Belgium consider that some centuries earlier is a more likely date, but I did not quote them, as they vary. Behind all this shortening there is still the Egyptian statement of 5500 B.C. There is no general acceptance of any one view, much to the confounding of European pre-history which hangs on the debate. To attempt to give here the reasons for any of these views would be far too extensive a matter; but impartiality requires that all of them should be stated, as I have done without expressing a preference.

However repugnant the compulsory livery of Herbert Spencer may be, to myself or others, I hope readers of NATURE will find in the "Descriptive Sociology" a fuller statement of Egyptian science than has yet been issued, beside the linking of the prehistoric ages with the later conditions which has not been written before. FLINDERS PETRIE.

BY "the Egyptian statement of 5500 B.C." Sir Flinders Petrie means the *modern* calculations based on the fragments preserved by ecclesiastical copyists of the Egyptian priest Manetho's "History of Egypt," written under one of the Ptolemies. His book contained a general review of the Pharaohs "with the lengths of their reigns, and the total duration of each dynasty" (H. Brugsch, "A History of Egypt under the Pharaohs" (trans.), London, 1879, I. 13). In the first place, a chronological series of such a purely relative nature obviously cannot contain an objective date such as 5500 B.C. for the first dynasty; nor, on the other hand, can a modern calculation—even if it only amounts to the sum of the lengths of the dynasties added to a given date B.C.—be legitimately considered an "Egyptian statement." In the second place, the evidence from the monuments has shown the "absolute necessity of supposing in the list of Manetho contemporary and collateral dynasties, and thus of diminishing considerably the total duration of the thirty dynasties" (*op. cit.* 32). Precisely the same thing happened in Babylonia, where the scribes made lists of the lengths of the dynasties and of their sums, and even of the sums of the total lengths of contemporary dynasties in different cities. Moreover, the necessity of making allowance on this account in dealing with Manetho's records was already appreciated by Brugsch in 1877, as is shown by the quotation above from the English translation of his "Geschichte Ägyptens unter den Pharaonen."

In 1917, Dr. Ludwig Borchardt published a reconstruction of the Palermo Stone and its then newly discovered fragment in the Cairo Museum (which he—unlike Gauthier, Gardiner and Petrie himself—considers to be part of a separate, though similar tablet), and by calculations based on this reconstruction convinced himself that the first dynasty must have begun at about 4186 B.C. This was accepted by certain German scholars at the time, *e.g.* Schaefer, the Director of the Berlin Museum: but not by Eduard Meyer, who was not impressed, and maintained his own chronology, published some years earlier, and from that time until this generally adopted (with slight differences) in Great Britain, in America, and on the Continent. One of the most important of these "slight differences" is Hall's addition of 200 years to the Second Intermediate Period, which brings the date for Menes back to 3500 B.C, instead of 3300 B.C. It is to this modification, proposed not only by a museum curator but an historian as well, that Sir Flinders refers when he says, "museum authorities in England, France and Belgium [not historians] consider that some centuries earlier is a more likely date." As the last date mentioned by him has been "4186 B.C.," the reader naturally assumes that he means "some centuries earlier" than that, instead of Meyer's 3300 which he really has in mind.

Borchardt's 4186 B.C. was "demolished" by Peet in the *Journal of Egyptian Archæology* for 1920, pp. 149 ff. Recently the process has been repeated by Eduard Meyer in his "Die ältere Chronologie des Ägyptens und Babyloniens." The reader has only to pick up half-a-dozen books written in the last three years in Germany to see how unanimously the 'shorter' dating has been accepted

THE REVIEWER.

Relative Intensities of Band Lines in the Infra-red Spectrum of a Diatomic Gas.

IN a previous theoretical discussion of the relative intensities of band lines in the infra-red vibration-rotation spectrum of a diatomic gas by one of us (E. C. Kemble, *Proc. Nat. Acad. Sci.*, 10, 274, 1924, and *Phys. Rev* 25, 1, 1925) the formula

$$a = \text{Const.}\ \frac{\bar{p}}{\nu}e^{-E''/kT} \quad \ldots \quad (1)$$

was derived. Here a denotes the area under the absorption coefficient curve for the line in question when plotted on a frequency scale, and $\bar{p}$ is the mean statistical weight of the two states involved in the transition; E'' is the energy of the lower energy level or initial state for absorption; ν denotes the frequency of the line. Comparison of this formula with the experimental absorption curves then available for the HCl band at 3.5μ indicated fair agreement between theory and observation, provided that $\bar{p}$ was calculated from the statistical weight formula

$$p = 2m + 1 \qquad m = \tfrac{1}{2}, \tfrac{3}{2}, \tfrac{5}{2}, \ldots \quad (2)$$

in which m denotes the nuclear rotational quantum number.

Fowler (R. H. Fowler, *Phil. Mag.* 49, 1272, 1925) and Dieke (G. H. Dieke, *Zeit. f. Phys.* 33, 161, 1925; cf. also E. C. Kemble, *Zeit. f. Phys.*, 35, 286, 1925) have shown that the summation rule leads to the above formula, but with the restriction that the statistical weight formula must be

$$p = 2m \qquad m = \tfrac{1}{2}, \tfrac{3}{2}, \tfrac{5}{2}, \ldots \quad (3)$$

thus giving $\bar{p}$ the series of valnes 2, 3, 6, 8, ...

In order to obtain a decisive test of the statistical weight formula, and also to verify the asymmetry of intensity of the two branches implied in formula (1) (the *R* branch should be more intense than the *P* branch in absorption), the writers have just completed a series of observations on the HCl band mentioned above, using very short absorption tubes. The data permit the determination of the integral absorption coefficients a for the lines observed, and the values thus obtained are in complete harmony with the summation rule.

Using a quartz prism spectrometer we have measured the absorption curves for six absorption paths ranging in length from 0·1 cm. to 3 cm. Curves were drawn of the areas of individual absorption lines plotted against tube length. The initial slopes of these curves give the desired values of a. The accompanying table shows the relative values of a deduced from the experiment, taking the value for the third line of the positive branch arbitrarily as unity. The absolute value of a for this line is 49×10^{10} sec.$^{-1}$. With the exception of the line −6, which is doubtful on account of the strong absorption in the quartz prism, the agreement between the experimental values of a and those computed from the theoretical formulæ (1) and (3) is within 4 per cent. of the absorption of the line +3. For all but two of the lines it is within 3 per cent. The maximum error becomes 10 per cent. if we use formulæ (1) and (2), and we are convinced that (2) is incorrect.

TABLE.

Line	+1	+2	+3	+4	+5	+6	+7
	0·500	0·853	1·000	0·959	0·774	0·542	0·333

Line	+8	+9	+10	−1	−2	−3	−4	−5	−6
	0·185	0·094	0·048	0·485	0·765	0·842	0·768	0·605	0·460

One surprising result of the investigation was the magnitude of the absorption with very short tube-lengths. The maximum observed absorption with a 1 mm. absorption path and a relatively broad slit was 16 per cent. From the shape of the area—tube length curves we can obtain at least a rough idea of the shapes of the lines, which are clearly very much narrower and deeper than previously supposed. Calculation indicates that radiation of wave-length corresponding to the centre of the strongest line is almost completely wiped out by the absorption in the first few millimetres of gas. The variation in shape of the area—tube length curves from line to line gives clear evidence of isotopic doubling and of the change in the doublet spacing due to the rotational isotope effect.

E. C. KEMBLE.
D. G. BOURGIN.

Jefferson Physical Laboratory,
Harvard University,
Cambridge, Mass.

Examination of Dead Sea Water for Eka-Cæsium and Eka-Iodine.

SEVERAL years ago it occurred to me that if eka-cæsium (element 87) is capable of permanent existence, it ought to be found in the Dead Sea. For ages rivers, streams, and rain, all charged with various salts, have poured into that sea, with practically no outlet save evaporation, so that an exceptionally high concentration of salts has resulted. It was not until July 1925 that I was able to visit Palestine and the Dead Sea. Summer is a particularly suitable time to obtain the water, as the enormous evaporation of surface water under the blazing sun causes a marked depression in the level of the Dead Sea, the water evaporating more rapidly than it is replenished by the Jordan, the rate of evaporation being thus estimated as exceeding six million tons of water per diem. Hence the accessible surface waters are more highly charged with dissolved salts than at other periods. This is reflected in their density, for which published data give values round about 1·1546 during the cooler months (Stutzer and Reich, March 1907). My sample was collected at the northern end of the Sea, at a depth of 2 feet, about 50 yards from the shore, and several miles west of the mouth of the Jordan. Its density at 18° C. was 1·2089, and thus more nearly approached the value given by Bernays for a depth of 300 metres, namely, 1·253.

Numerous analyses of Dead Sea water have been published from time to time and the presence recorded of the following ions: Na, K, Mg, Ca, Fe, Al, Cl, Br, I, SO_4, CO_3 and NO_3. My sample contained small but appreciable quantities of strontium, which does not appear to have been observed before. The amount of iron in the waters near the northern shore may now be expected to increase, in view of the erection of a number of crude dwellings on the beach, constructed of wood and flattened-out petrol tins. Many such tins lie also in pools and ditches hard by, imparting a deep ochreous stain to the salt that has crystallised out.

Assuming eka-cæsium to manifest in its salts the same gradation in properties as the other alkali metals, the chloride should be more soluble than the corresponding potassium salt and the chlorplatinate less soluble. After removal of all metals save those of the alkali group from a portion of the sea water, sodium chloride was fractionally crystallised out and potassium chlorplatinate precipitated from the concentrate. Gravimetric analyses showed that if any eka-cæsium were present, its amount was too small to be detected in this way with my limited supply of material. A sample of the chlorplatinate was accordingly sent to Messrs. Adam Hilger, Ltd., who submitted it to X-ray analysis in their laboratory. Several photographs were taken and good lines obtained in the region where eka-cæsium *L* radiations would fall. A line of wave-length 1 037 was recorded, and it was at first thought that this might correspond to the $L\alpha$ radiations of eka-cæsium; but this was apparently not the case, since no corresponding $L\beta$ line could be detected.

The optical spectrum of a sample of potassium chloride, reduced from some of the chlorplatinate, was also photographed by Messrs. Hilger, but the only impurities we were able to identify were traces of sodium and calcium. It would appear, therefore, that eka-cæsium does not exist in the waters of the Dead Sea. Consideration of its position in the Periodic Table, between radon and radium, would suggest that eka-cæsium may itself be radio-active and short-lived, which latter property might render its detection extremely difficult.

A search was likewise made for the presence of eka-iodine (element 85) on the assumption that its silver salt would more be insoluble in water than silver chloride. The latter was fractionally precipitated and exposed to X-ray examination, but without result.

J. Newton Friend.

Municipal Technical School,
Birmingham,
May 1.

Influence of Electrical Field on the Adsorption of Neutral Molecules.

Not only the adsorption of ions, but also the adsorption of undissociated molecules, depends on the direction and strength of the electrical field at the interface between the adsorbing body and the solution. This circumstance is illustrated by the electrocapillary curves which are obtained if a solution in contact with mercury contains organic substances.

According to Gouy, at a sufficient distance from the maximum the lowering of the interfacial tension by the organic substance vanishes, which means that an intense electrical field prevents the adsorption of organic molecules. The reason for it is that such a field, as it has been recently shown by one of the present writers (*Zeitschr. f. Phys.* 35, 792, 1926), tends to expel organic molecules having a lower dielectric constant and to attract water molecules. The adsorbing action should therefore reach a maximum in the absence of the ionic double layer, *i.e.* at the maximum point of the electrocapillary curve. As a matter of fact, if a molecule being adsorbed charges the mercury surface positively, the maximum of adsorption is somewhat displaced with respect to the maximum of the electrocapillary curve towards the region of negative charge (the case of aliphatic acids and alcohols) and vice versa.

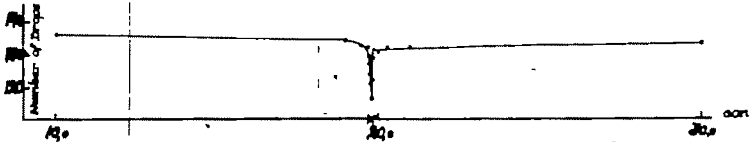

Fig. 1

Starting from this consideration it was natural to look for similar phenomena in the case of solid adsorbing substances. Silver iodide proved a very suitable object in this respect. Investigations of Lottermoser and Fajans have shown that silver iodide precipitated from a solution containing an excess of silver ions is charged by these ions positively, whereas in the presence of an excess of iodine ions it is charged negatively. The potential difference between the solution and solid silver iodide varying with the concentration of silver ions in the same way as in the case of a silver electrode, the point at which concentrations of iodine ions and silver ions are equal corresponds for silver iodide to the maximum point of the electrocapillary curve, and near to it a maximum of adsorption for neutral molecules should be expected.

The method adopted for the measurements was the following: to 20 c.c. of an acidified 0·5 N solution of silver nitrate containing a definite quantity of caprylic acid, a similar solution of potassium iodide was added in small portions. After each addition the concentration of caprylic acid in the solution was determined by its surface tension, measured with a stalagmometer. The data obtained in one series of experiments are plotted on Fig. 1. In the proximity to the point of neutralisation a sharp minimum in the number of drops is observed, which corresponds to a minimum value of caprylic acid concentration in the solution, *i.e.* to its maximum adsorption by the precipitate. The maximum point is somewhat displaced in the direction of an excess of potassium iodide, just as in the case of the adsorption on a mercury surface.

We intend to apply this method to the study of electrocapillary curves of solid metals.

A. Frumkin.
A. Obrutshewa.

Karpow Chemical Institute,
Moscow, March 18.

Infra-red Emission from Gaseous Explosions.

The catalytic effect of water and other substances on the speed of explosions of mixtures of carbon monoxide and oxygen has been studied from the point of view of infra-red emission. This has been rendered possible by the use of a Downing galvanometer kindly loaned to us by Prof. A. V. Hill. With this galvanometer and a Hilger infra-red spectrometer, it is a comparatively easy matter to survey the infra-red spectra of gaseous explosions. The explosion spectrum of carbon monoxide and oxygen is qualitatively the same as that of the flame, but the ratios of the intensities of the 2·8μ and the 4·4μ bands are widely different in the two cases. For the explosion of the gases dried over P_2O_5 this ratio is nearly 1 : 1 for a 35 cm. tube, and for the flame 1 : 11. When the gases are saturated with water vapour the ratios are 2 : 1 and 1 : 10 respectively. The intensity of infra-red emission is markedly greater for the dry than for the wet gases, although the speed of explosion in the former is slower. The ratios of the deflexions obtained for the dry and wet gases were about 3 : 2 for the 2·8μ band, and 3 : 1 for the 4·4μ band. The absorption of infra-red radiation by the water vapour in front of the explosion wave is negligible (cf. Hettner, *Ann. Phys.*, 1918, 55, 496). This we have checked by absorption measurements on the wet and dry explosive mixtures. Thus the decrease in the infra-red emission which occurs when water is added to the explosion of carbon monoxide must be ascribed to some cause operating on the hot gases themselves.

Two mechanisms may be put forward to explain the catalytic action of water which take into account the bearing of the decrease in the emission of infra-red radiation on the increase in the speed of reaction. The reduction in the intensity of the radiation may be due either to its absorption or to the prevention of its emission by the water molecules. In the latter case, the internal energy of those activated molecules which emit the 2·8 and 4·4μ bands may be converted by collision with the water molecules into kinetic energy. It is difficult to decide between the two possibilities, but in view of the high transparency of flames to their own radiation, the collision mechanism would appear to be the more probable of the two explanations.

Ethyl iodide and ethyl nitrate are still more powerful catalysts for the carbon monoxide and oxygen explosions than water, and the addition of a few per cent. of these substances reduces the intensity of emission of 2·8 and 4·4μ bands to about one per cent. of that emitted by the pure dry mixture. Here again the absorption in front of the wave is insufficient to account for the results.

W. E. GARNER.
C. H. JOHNSON.
S. W. SAUNDERS.

University College, London, April 29.

A Very Rare Halo.

ON Sunday, May 16, at 16.25 I noticed a double halo round the sun. There was much cumulus and fracto-cumulus at the time, but this cleared off later, and at about 17.30 the sky was clear except for some clouds near the horizon; at this time both halos were well seen, each extending to well over a semicircle. Except for the cumulus near the horizon the sky seemed at first sight to be absolutely blue and cloudless, but by looking carefully in the neighbourhood of the halos very faint strands of cirro stratus were seen. Both halos had a tinge of red on the side nearest the sun, but otherwise were white; they were equal in brightness except for a short time when the inner halo brightened on the right-hand side of the sun for some 30° or so, the colour at the same time becoming rather more marked. Before sunset both halos faded, the inner one disappearing first. The radius of the inner halo to the middle of the band was from 18° 30′ to 18° 40′ as measured with a sextant. Better measurements, perhaps, were obtained from a photograph taken on a panchromatic plate through a Wratten A (deep red) filter; this gave the radii for the inner halo of 17½° to the inner edge and 21° to the outer edge, for the outer halo 22½° and 26½° respectively. The photograph was taken with a wide angle lens, and allowance was made for distortion away from the centre of the plate in making the above measurements.

Three halos are known inside the halo of 22°; the first has a radius of 7½° to 10°, the second 17° to 18°, the third 18½° to 20°. The halo seen here was obviously the second, or Rankin's halo. Besson (*Comptes rendus*, 1920, 170, 334) mentions this halo as having been recorded six times. There is some uncertainty as to the exact radius, and the matter is of some importance in connexion with the theory of these abnormal halos (see Besson and Humphreys, *Monthly Weather Review*, 1923, pp. 254, 255); for this reason, and also because Rankin's halo is excessively rare, I have gone into the matter rather fully. Halos are difficult to measure accurately, and the above measurement of 17½° is probably as accurate as any previously made; on several occasions when this halo has been observed the measurements were admittedly not very accurate. So far as I know it has never been photographed before.

On May 16 the two halos were seen over a wide area, reports having come from the counties of Suffolk, Essex, Kent, London, Surrey, Sussex, and Hampshire. As seen here in a nearly clear sky, they formed the most striking meteorological phenomenon that it has ever been my good fortune to witness.

C. J. P. CAVE.

Stoner Hill, Petersfield, May 23.

The Transmission of Signals from a Horizontal Antenna.

IN the course of a mathematical investigation of the propagation round the earth of electromagnetic waves from a horizontal antenna, the result has emerged that, when the earth is regarded as a perfect conductor, the components of electric and magnetic force are zero both when the earth is regarded as surrounded by a conducting Heaviside layer and when no layer is present. Finite conductivity of the earth must thus be assumed in order to account for the propagation, and it is then found that the resulting forces are a small vertical electric force and a much larger horizontal magnetic one. The electric force is due to the 'space waves,' the magnetic force to the 'surface waves' described by Sommerfeld (*Annalen der Physik*, vol. 28 (1909), p. 665); the result of the analysis is in remarkable agreement with the conclusions he there expresses. The magnetic force may be analysed into perpendicular components, each of which consists of two simple harmonic oscillations differing in amplitude and phase, results of the same general type being obtained both with and without the Heaviside layer.

Numerical investigations of the magnitudes of the forces and their variation with distance from the source are in progress.

MARY TAYLOR.

Mathematical Institute,
The University, Göttingen,
March 31.

Rustless Steel and Flexible Glass 5000 Years Ago?

WHILST looking up the literature connected with ancient glass, in which I am interested, I came across a book by M. A. Wallace-Dunlop, published in 1883, entitled "Glass in the Old World."

An account is there given of the alleged opening of the first and second pyramids of Gizeh.

As these pyramids are known with tolerable certainty to have been built between 3969 and 3845 B.C., we may conclude that the things found in them when first opened must have been made at least five thousand years ago.

It is stated, on the authority of one Ben-Abd-er-Rahman, that in the year A.D. 829 El-Mamoum, son of Haroun-al-Rasched, was the first who succeeded in penetrating the tomb of Cheops, and found there the mummy of the king, and that he also entered the west pyramid (second pyramid ?), and that there was found "thirty treasures filled with store of riches, and utensils, and with signatures made of precious stones (signet rings ?) and instruments of iron and vessels of earth, and with *arms which rust not*, and with *glass that might be bended and not broken*." The italics are mine.

Those ancients have a most exasperating way of anticipating our new ideas.

JAMES H. GARDINER.

Harrow.

Transmission of Stimuli in Plants: A Correction.

IN a communication dated May 22, Prof. Ricca asks me to point out that there is an error in his letter as printed in NATURE of May 8, p. 655. There it is stated that the closing of the pinnules from base to apex of a pinna indicated times of transmission of the stimulating substance from the base to the apex of the pinna of 5, 4, 3½, 2½, 2 min. This of course should read, 5, 4, 3½, 2½, 2 sec.

HENRY H. DIXON.

Trinity College, Dublin,
May 28.

The Element of Atomic Number 61; Illinium.

By J. A. Harris, L. F. Yntema, and Prof. B. S. Hopkins, University of Illinois.

An important result of the development of Moseley's atomic number rule has been the impetus it has given to the search for missing elements. It is true that later arrangements of the Periodic Table indicated that eka-cæsium, eka- and dwi-manganese, and eka-iodine were missing, but there were no theoretical grounds for supposing that eka-neodymium might exist until Moseley's rule showed that element number 61 was still to be identified. Moseley's work was of inestimable value to one engaged in completing the list of chemical elements for several reasons—first, it gave definite information as to the existence and location of gaps in the Periodic Table; secondly, it gave a basis for the calculation, prior to its discovery, of the X-ray spectrum of an element and indicated a technique by which lines in that spectrum might be identified; and, finally, it originated a method of examination so searching that a mixture of two elements, so closely similar in chemical properties as to be almost inseparable, could be definitely analysed. Were it not for the work of Coster and Hevesy on the X-ray examination of zirconiferous minerals, the presence in them of element number 72 would probably be still unsuspected and hafnium (or celtium) would still be listed among the rare earths. Chemical tests made on zirconium ores had frequently indicated the non-homogeneity of zirconium, but they could not give the definite proof afforded by an X-ray analysis.

The proof that a rare earth element was missing, the atomic number of which would place it between neodymium and samarium, explained the sharp break in the sequence of properties that comes in the rare earth group between those two elements. The differences in solubilities of the double salts formed by rare earth nitrates with magnesium nitrate appear to be quite uniform, excepting in the case of neodymium and samarium, since fractional recrystallisation of that double salt will accomplish a strikingly sharp separation of those two elements. There is the same break in the sequence of solubilities of other salts, in basicity, as indicated by the rate of hydrolysis, etc. It also appears that the absorption spectra show the same general variation, and, as will be shown later, the absorption bands of element number 61 seem to fit into the regular sequence.

Because element number 61 might be expected to share the striking similarity in properties and the common occurrence in minerals of the other members in the rare earth group, it seemed logical to institute a search for it in monazite sands, a mineral in which the first members of that family, the so-called cerium earths, predominate. Since that mineral is rich in neodymium, 60, and in samarium, 62, it would be surprising to learn of the absence of 61 there and its presence in a mineral containing little or none of 60 and 62.

The original material used in the investigation was the rare earth residue remaining from monazite sands after the extraction of thorium and part of the cerium for use in the manufacture of Welsbach mantles. It was given to this laboratory by the Lindsay Light Company of Chicago. After the remaining cerium was removed by the usual methods, the other rare earths were fractionally recrystallised as double magnesium nitrates. Very pure neodymium and samarium, the latter subjected to further purification by other methods, were sent to the Bureau of Standards at Washington for use in an extensive investigation being pursued on the infra-red arc spectra of the rare earths. It was found that a number of identical new lines were present in both samples, and the suggestion was made that they might be due to the presence of a small amount of a new element. Eder had noted the same phenomenon. Later, when the ultra-violet arc spectra of neodymium, samarium, and of intermediate fractions containing both were examined, lines common to all three were found. However, X-ray analysis of those same samples showed no indication of the presence of an element with atomic number 61. Prandtl and Grimm had subjected rare earth material to separation by the same method and then to a fractional precipitation with ammonia, and could find no evidence of the missing element by X-ray analysis.

It seemed that the solubility of the double magnesium salt of element number 61 is very similar to that of neodymium, and its separation by recrystallisation of that salt offered little hope of success. The order of solubility of the bromates of the cerium group earths is the reverse of the order obtaining with the double magnesium nitrates, and that suggested a means of separating neodymium and thus concentrating element number 61. It is easier to separate a small amount of one element from a larger amount of a second if the former is in the less soluble end of the series of recrystallisations. Accordingly the neodymium-rich material thought to contain element number 61 was converted to bromate and again recrystallised.

A marked change in the absorption spectra of the solutions that began to appear after repeated recrystallisation indicated the probable concentration of the missing element. Two bands, one at 5816 Å.U. and another at 5123 Å.U., that had shown very faintly in supposedly pure neodymium, became stronger in some fractions as the other neodymium bands disappeared. Because these two bands, if assigned to element number 61, find their places in a more or less regular sequence shown by bands of neighbouring elements, it was thought they might belong to that element.

X-ray analysis confirmed the theory and showed the presence of element number 61 in those fractions. A mean value of five determinations of 2·2781 Å.U. was found for the $L\alpha_1$ line and one determination of 2·0770 Å.U. for the $L\beta_1$ line. A faint indication of the $L\beta_3$ line was also noted. It is assumed that these results prove the presence of element number 61.

The name assigned to the element is Illinium (Il).

There are several reasons that may be advanced to explain why the element escaped detection by means other than X-ray analysis. It must be extremely rare. Its solubility in a series of fractional recrystallisation is next to that of the very abundant neodymium, which tends to spread into the illinium-rich members of a series. The large number of absorption bands exhibited by both neodymium and samarium would tend to mask its absorption spectrum. Finally, the solubility of its double magnesium nitrate, which salt is commonly used for the separation of closely related elements, is close to that of neodymium. Evidence supporting this latter is found in the fact that the absorption bands at 5816 Å.U. and 5123 Å.U. found in supposedly pure neodymium purified by that method are shown to belong to illinium.

The identification of illinium as the missing rare earth completes the list of rare earth elements. Work has been instituted involving the extraction of several hundred pounds of the crude material with the purpose in view of obtaining enough of the element in pure enough state to study its properties, its relationship to other members of the group, and its atomic weight.

The Periodic System, Chemical Bonds, and Crystal Structure.[1]

By Prof. A. SOMMERFELD, For. Mem. R.S., University of Munich.

A GREAT advance was made in the Bohr theory of the Periodic System by the discovery of Stoner and of Main-Smith that the numbers of electrons in the different subdivisions of the $L, M, N, \ldots$ shells are not equal, as Bohr originally assumed, but unequal. The details of the new scheme are given in the following table, which shows the sub-groups of the shells, with the numbers of electrons in each:

TABLE OF X-RAY LEVELS.

	n_{11}	n_{21}	n_{22}	n_{32}	n_{33}	n_{43}	n_{44}
K	2	..	..	..	..	..	..
L	2	2	4	..	..	..	..
M	2	2	4	4	6	..	..
N	2	2	4	4	6	6	8
	n_1	n_2		n_3		n_4	

It will be noticed that the K-shell is single, the L-shell triple, the M-shell fivefold, and so on, in agreement with X-ray data (three L absorption edges, etc.). For the principal quantum numbers we still have of course $n=1$ in the K levels, 2 in the L levels, and so on.

At the top of the table is the quantum number notation which we find necessary for classifying X-ray spectra. There are, besides the principal quantum number n, two subordinate ones which we write as suffixes. They are denoted either by k_1 and k_2, or by k and j, and it is understood that while $k_1=k$, $k_2=j+\frac{1}{2}$; j is the so-called inner quantum number, and is, according to our scheme (developed in a previous lecture), half-integral, in the same way as in the alkali spectra. The two types of spectra are analogous, as is emphasised especially by Landé. We increase the magnitude of j, merely for typographical reasons, by $\frac{1}{2}$, so as to obtain a whole number k_2, in agreement with our practice in the case of the alkalis.

The numbers in the body of the table are now throughout equal to $2k_2=2j+1$. But $2j+1$ is the quantum weight, or number of orientations of the angular momentum j in a magnetic field, so that Main Smith and Stoner make the number of electrons in a given energy level equal to the quantum weight, $2j+1$, of that level.

At the foot of the table the numbers n_k describing the orbital types are given. We must direct special attention to the fact that any two shells that form a 'relativity doublet' in the X-ray spectra belong to the *same* orbital type n_k, which is in complete opposition to the original view from which the relativity formula was derived.

In replacing n_k by n_{kj}, we are introducing the same problem as has arisen in the case of the visible spectra. The characteristics of the orbit of a single electron ought to be fully determined by two quantum numbers, n and k, together with a third, m, to give the orientation of the orbit in space; that is to say, corresponding to the three degrees of freedom of the rotating electron, we should have altogether three quantum numbers. But we have already seen (in the earlier lectures) that even with hydrogen we require a j in addition to n, and k, or three quantum numbers merely for the characteristics of the orbit, which is thus not fully described without four numbers. We need not be surprised then when the same problem arises with X-ray spectra, so that here also a single orbit must be described not as an n_k orbit but as an n_{kj} orbit. May we hope that the solution of the difficulty will be found along the lines of the new quantum mechanics introduced by Heisenberg and developed, for example, by Dirac? It is true we are confident that this will dispose of the old difficulties as to half-quantum numbers, and so on, that arise especially in the anomalous Zeeman effect; but it seems unlikely that it will succeed in providing a new degree of freedom for the orbital electron. Most probably we shall be compelled to make a new hypothesis that will introduce this into the Hamiltonian function of the system. In this connexion we may recall the striking suggestion of S. Goudsmit of the 'spinning electron' (proposed, in some respects, by Porson previously, though Porson gave no definite relations to quantum numbers); it may be that here we shall find the explanation of the missing degree of freedom.[2]

The j of the individual electron must not be confused with the j of the whole atom, the outermost shell of which is composed, in general, of several orbits of the type in question. This latter j we will distinguish by a bar, so that $\bar{j}$ refers to the atom as a whole; moreover, it refers to the atom in its fundamental or unexcited state. In other words, $\bar{j}$ is the inner quantum number of the fundamental term. In 1925 I enunciated two theorems in the *Physikalische Zeitschrift*, about this $\bar{j}$ of the fundamental term and its relation to the position of the element in the periodic table:

1. Every completed sub-group is distinguished by $\bar{j}=0$.

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[1] From a series of University of London lectures on "Atomistic Physics," delivered at the Royal College of Science during March 1926.

[2] Indeed, from a paper of Heisenberg and Jordan, now in print in the *Zeits. f. Phys.*, it appears that both new mechanics and 'spinning electron' are needed in order to account for the relativity doublet arising between two levels that differ by j and not, as in the original theory, by k.

2. The element immediately following or preceding the one that completes a sub-group has a value of $\bar{j}$ that is identical with the j of the sub-group to which the element belongs.

The following scheme will give examples of these theorems:

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII. ….	XVII	XVIII.
$j=$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{2}$	$\frac{3}{2}$	$\frac{3}{2}$	$\frac{3}{2}$	$\frac{3}{2}$	$\frac{3}{2}$	$\frac{3}{2}$	$\frac{3}{2}$	$\frac{5}{2}$ ….	$\frac{5}{2}$	$\frac{5}{2}$
$\bar{j}=$	$\frac{1}{2}$	0	$\frac{1}{2}$	0	$\frac{3}{2}$	..	$\frac{3}{2}$	0	$\frac{3}{2}$	..	..	0?	$\frac{5}{2}$ ….	$\frac{5}{2}$	0

The Roman figures give the number of electrons in the outermost shell (whichever that is) in the various cases. The numbering is from the beginning of that shell, and applies equally well to the N shell as to the M, and also to the L shell in so far as it has enough electrons.

I can only touch very briefly on the spectroscopic evidence for this scheme, and must omit all details: $\bar{j}=0$ is found for column II. in helium and the alkaline earths, and for column IV. in tin and lead, and probably also in ionised nitrogen (N^+). For column VIII. it is established by neon (we considered in our second lecture the neon $^1S_0$ term); for column XII. it is doubtful, and XVIII. (nickel, palladium, platinum) will have to be considered further below. $\bar{j}=\frac{1}{2}$ denotes, in column I., the s term of the alkalis, and in column III. the $^2P_1$ term of aluminium, gallium, indium, and thallium; and so on for the others.

Of course we may expect in addition that the azimuthal quantum number of the last-bound electron will be the same as the k of the Periodic System, *i.e.* as the first suffix in n_k. This is indeed the foundation, on its spectroscopic side, of Bohr's theory of the Periodic System. However, this k is different, in the case of atoms having several valency electrons, from the 'group quantum number' l, introduced (though their notation is different) by the work of Russell and Saunders on the alkaline earths. The exceptions to the Bohr scheme which iron and titanium, for example, appear to provide are founded on a confusion between k and l which Russell and Saunders were the first to avoid.

We come now to chemical applications. We may state the basic principle of chemical binding as a tendency towards the formation of complete sub-groups. The complete group of eight electrons has been familiar for some time, and it is well known how the simplest binary compounds approach this inert-gas configuration from both sides. The next in importance is the 'two-shell,' typified especially by helium, in which two electrons rotate in opposite directions, so that their moments cancel out. As an example of this we may cite $LiH = Li^+H^- = He_3He_1$.[3] However, the elements zinc, cadmium, mercury, belong to this class too, having a pair of outer electrons bound in a similar manner, and we know of many very stable compounds which are approaching this configuration. I will mention only a few, such as PbO (or PbS), in which the lead is divalent or, in other words, is reduced to the two-shell of mercury, having given two electrons to the oxygen or sulphur. PbO is actually more stable than PbO_2, although in the latter compound the lead has what used to be regarded as its 'correct' valency. We may note also the compounds of monovalent thallium and of trivalent arsenic, antimony, and bismuth, all of which are aiming at the two-shell or helium type. Main Smith and Stoner have thus left no room for doubt that in future chemists, in their speculations about affinity, will have to take into account as equally authenticated, not only the eight-shell of the inert gases, but also the two-shell.

We come now to the so-called eighteen-shell which is, one supposes, completed at the ends of the triads by nickel, palladium, and platinum. There is no doubt that the following elements—copper, zinc, silver, cadmium, gold, mercury—in their chemical compounds are often reduced to the eighteen-shell. But is this shell in fact complete, like the inert-gas shell? What are the conclusions of spectroscopy as to the fundamental states? With palladium the position is clear and unambiguous: the fundamental term is here a $^1S_0$ term lying well below the other levels. Palladium has thus a completed shell. This does not hold for nickel or platinum. In nickel the fundamental term is a ^3F term, with a $^3D'$ level slightly higher, and in platinum a $^3D'$ term. This is reflected in the chemical and spectroscopic behaviour of the following elements—copper, silver, and gold. Silver is without exception monovalent; on the removal of its single valency electron it goes over into the stable palladium configuration. Copper is mono- and divalent; gold mono- and trivalent. Here then, in addition to the valency electron, one or more of the electrons of the core of the atom may be detached. The core in the case of copper and gold is not completed, which agrees with what we have found for nickel and platinum.

The same impression is gained from their spectroscopic behaviours. Silver has a simple spectrum resembling that of the alkalis, while the spectra of copper and gold show in addition to the alkali doublet system a large number of foreign lines. It is very characteristic that Fräulein Stücklen[4] has found for the most stable state of copper not the s term of the doublets, but one which probably belongs to a quartet system. That corresponds exactly to the uncompleted shell of nickel. The position of an element in the periodic table thus gives us very decided clues for unravelling its spectrum.

The behaviour of nickel and platinum and, what is intimately bound up with them, the behaviour of copper and gold, must be regarded as a partial exception to our rule about resultant moments of momentum $\bar{j}$; $\bar{j}=0$ is indeed the mark of a completed sub-group, but in some cases the last electron, which might have performed this rôle, is, from considerations of energy, more easily accommodated elsewhere.

We come now to the final members of those sub-groups which are distinguished from the following sub-group by a different value, not of k but of j, so that they belong to the same orbital type, n_k, as the following elements. It appears that this division is less well marked, and makes itself less noticeable chemically than the close of the sub-groups already considered. If we take first the division between n_{43} and n_{44} (for $n=4$) in table I., we find that this occurs in the rare earths; and corresponding to it is the difference between cerium earths and ytterbium earths, which is especially noticeable magnetically. The curve for the paramagnetism of the ions rises, according to Cabrera and Stefan Meyer, to a maximum, then falls off almost to zero at the end of the cerium earths, reaches a higher maximum with the ytterbium earths, didymium, and holmium, and falls finally to zero at cassiopeium ($Z=71$).

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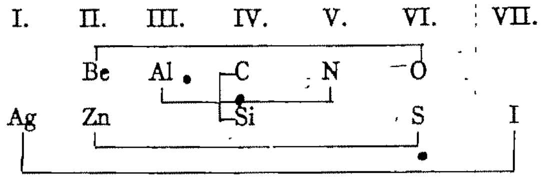
[3] He_3 denotes a He-configuration with nuclear charge 3, $=Li^+$, and similarly for He_1.

[4] *Zeits. f. Phys.* 34, 562, 1925.

The close of the sub-group n_{33} appears, as we have already said, not to be noticeable spectroscopically; in contrast to this we have found that the close of n_{21} is marked by $j=0$ in tin and lead, and probably also in carbon and silicon. But how about the chemical effects of the close? Are there compounds which are aiming at the four-shell as there are for the eight-, two-, and eighteen-shells? The answer will be of great interest for the understanding of chemical compounds, and towards it I can make the following contribution, based on an observation of H. G. Grimm relating to the crystal structure of certain diamond-like compounds. The subject is treated in a paper by Grimm and myself in the *Zeitschrift für Physik* (1926), where also the above remarks about copper, silver, and gold may be found.

The characteristic structure of diamond is known from the work of Sir William Bragg. Diamond is built up simply of tetrahedra in such a way that every carbon atom is surrounded by a tetrahedron of other carbon atoms. Zinc sulphide crystallises in the same arrangement, as zincblende, with each zinc atom surrounded by a tetrahedron of sulphur atoms and vice versa, but it also crystallises in another way, as 'wurtzite'; in this, while we still have interpenetrating tetrahedral systems, the structure is not cubical but hexagonal; the tetrahedra are merely disposed in a different way, in relation to one another, from that which occurs in the diamond. We will classify both together as tetrahedral structures. The crystal carborundum (CSi), so important technically, is likewise tetrahedral, with different modifications, which are distinguished by the way in which diamond- and wurtzite-structures alternate with one another in the hexagonal *c*-axis. As a result of this alternation the repetition-distance is here extraordinarily large—almost 40 Å.U., indeed, in one of the modifications.

Now, however, we have this to consider: this tetrahedral structure occurs not only in the fourth column of the periodic table (*e.g.* in carbon, silicon, carborundum, germanium, tin), but also in compounds of neighbouring elements; those neighbours being equally distant on opposite sides from the fourth column. We may in fact state as a definite theorem that tetrahedral symmetry occurs *only* in such binary compounds as have both components at most three places from a four-shell, and both equally distant.



It is very natural to assume that in all these compounds the mechanism of the bonds is the same as in the diamond. This is quite obviously a non-polar bond, since it unites two similar atoms, and we conclude that in zinc sulphide it is also non-polar; *i.e.* the compound is not $Zn^{++}S^{--}$. This is confirmed by X-ray intensity measurements, which, according to H. Ott, certainly do not correspond to Zn^{++} and S^{--}, but probably to neutral Zn and S. The idea of a four-shell would have suggested even the reverse picture, Zn^{--} and S^{++}, since the sulphur atom must give up two electrons if it is to be reduced to the four-shell of silicon, and zinc must acquire two to reach that of germanium; however, the intensity relations seem rather to indicate neutral Zn and S. Similarly, beryllium oxide, in contrast to magnesium oxide and calcium oxide, is at least not the polar salt $Be^{++}O^{--}$. In calcium oxide and calcium carbonate tetrahedral structure is not observed, nor is it to be expected theoretically, since calcium is not two places before a four-shell.

I prefer not to go further at present into the mechanism of the reciprocal binding of such four-shells; even in the simplest case of the diamond we know nothing certain about it. It is most probable that the binding is performed by pairs of electrons, each of which goes round two carbon atoms, as in G. N. Lewis's theory of the sharing of electron pairs.

In conclusion, then, we have found that the theory of the Periodic System shows at what elements we are to expect completed sub-groups. In addition to the inert-gas eight-shell, the shell of eighteen, and even more that of two electrons, is a goal at which the elements in a stable compound are aiming. The four-shell, on the other hand, is evidenced by a tetrahedral crystal structure, which points to the same kind of binding together of the atoms as we have in the diamond; this binding is not performed by the electrostatic attractions of polar ions of the usual sign, but is probably a matter of neutral atoms. It seems reasonable to hope that the great chemical problem of the non-polar bond will be brought nearer its solution by a close study of tetrahedral crystal structures.

The Shipworm.[1]

By Dr. W. T. CALMAN, F.R.S.

ALTHOUGH nowadays iron ships no longer fear the *calamitas navium*, as Linnæus called it, the shipworm still remains a constant source of anxiety to harbour engineers in many parts of the world. For example, the damage caused by it to wharves and jetties on the shores of San Francisco Bay, during the years 1919 and 1920, was estimated at no less than 15,000,000 dollars.

Within the last few years a good deal of attention has been paid to the shipworms by investigators in

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[1] Substance of two lectures delivered at the Royal Institution on April 17 and 24.

Great Britain and, more especially, in America, and noteworthy additions have been made to our knowledge. Only a few of the more striking results can be touched on here.

The question of how the shipworm excavates the wood to form its burrow has been much discussed. The earlier observers had no doubt that the valves of the shell—which they called the teeth—were the instruments of excavation, but some later writers have supposed that the wood was acted on by a solvent secretion and then rubbed away by the fleshy foot. Lately Mr. R. C. Miller, in America, has been able to watch the animal at work, by laying bare the inner end of the burrow and cementing a cover-glass over the opening. He found that the sucker-like foot adheres now to one part and now to another of the inside of the burrow, and the animal is wedged firmly in position by the swelling up of a fleshy lobe lying over the back of the shell. A rocking movement of the valves produced by alternate contractions of the two adductor muscles causes the rows of minute teeth on the surface of the valves to rasp away the wood, and, as the foot shifts its position after each stroke, the boring proceeds evenly and the circular form of the burrow is preserved. In hard and fine-grained wood, microscopic parallel scratches can be observed which are the tool-marks of the excavator.

Most bivalved molluscs feed on minute living organisms and organic particles suspended in the water, and the food-collecting function of the so-called gills is at least as important as their respiratory function. It is possible that the shipworm obtains a part of its food in this way, but it also swallows the fine sawdust produced by the rasping movements of its valves, and the stomach and intestine are found on dissection to be crammed with wood-pulp. This does not prove that the wood is actually a source of food, for some related molluscs (Pholadidæ) that bore into rock, similarly swallow the innutritious mud produced by their boring operations. As compared with the Pholadidæ, which burrow only to get shelter, the elongated worm-like shape of the shipworms (some of which are six feet long) suggests the need for continued boring to obtain food while keeping in touch with the surrounding water at the mouth of the burrow. Recent work, however, shows that the wood is actually digested. Potts has observed phagocytic ingestion of wood-particles in the 'liver,' while Harrington found that an extract from the same gland acted on sawdust to produce glucose. Dore and Miller, in America, have analysed the borings after passing through the alimentary canal of the shipworms and compared the composition with that of the wood itself. They found that while the amount of lignin remained unchanged, the cellulose was reduced by 80 per cent. and the hemicelluloses by 15-56 per cent.

This, however, is not the whole story. It seems to be well attested that, in certain circumstances, the shipworm ceases to bore and shuts itself completely off from the wood by continuing the shelly lining over the end of its burrow. Where this has been done, the only source of food-supply will be the suspended particles drawn in by the respiratory current. The same is probably true of the somewhat mysterious giant shipworm, *Kuphus arenarius*, which does not bore into wood but lives vertically embedded in the mud of mangrove swamps with only its siphons projecting from the surface.

The practical man, when confronted with problems such as those presented by the shipworm, is sometimes apt to pay too little heed to the history of the subject and to waste time in finding out for himself facts that were discovered and recorded long ago. The learned Sellius, two hundred years ago, was at pains to confute the suggestion that the shipworm could emerge from its burrow and swim away to bore into a fresh piece of timber. Such a supposition was natural enough when nothing was known of the microscopic free-swimming larvæ, but it is surprising to find it revived in an official report issued only three years ago by the Department of Scientific and Industrial Research.

It is characteristic of the shipworm that it may appear suddenly in places that have previously been free from its depredations. Thus we find records of great outbreaks of shipworm in Holland in 1730, 1770, 1825 and 1858, at San Francisco in 1917, and so on. In most of these cases the damage is severe for two or three years, then the attack dies away and little or nothing is heard of the pest in the intervening periods. When one of these outbreaks occurs, the practical men generally begin by attributing it to importation of infection from abroad. In Drake's time the shipworm was commonly regarded as having been brought from the New World. In the eighteenth century the East Indies were supposed to be its place of origin. Linnæus concisely says of it, "ex Indiis in Europam propagata." In the recent San Francisco outbreak something was said of importation from Europe.

It is possible that some truth may underlie these beliefs. The commonest species of shipworm in northern Europe, *Teredo navalis*, has been found in places so widely separated as the Cape of Good Hope, Australia and San Francisco, and there is every probability that this wide range, unusual in a marine invertebrate, is due to the species having been carried to these distant parts in the timbers of ships. But it is unlikely that the individual outbreaks can often be due to this cause. It is certain that in most cases the shipworms have lurked unnoticed in odd corners until rapid multiplication owing to favourable conditions has directed attention to them. It becomes of importance, therefore, to determine what these favourable conditions are.

Individual outbreaks have sometimes followed years of deficient rainfall, leading to increased salinity in the waters of bays and harbours, and attempts have been made to find out the degree of salinity which is most favourable. It was found at San Francisco that *Teredo navalis* was active and apparently thriving at a salinity of 15 per thousand, that is to say, in water containing rather less than half the amount of salt usually found in ocean water. As the water was diluted the animals became less active until at 4 per thousand they withdrew into their burrows. While enclosed in the wood, however, they remained alive, though inactive, for three weeks in fresh water, ready to resume operations when replaced in salter water. It would be interesting to know how the free-swimming larvæ are affected by changes of salinity, but there appear to be no detailed observations on this point.

All these observations, however, have been made on a single species, *Teredo navalis*. There are many other kinds of shipworms and, although we know little of their habits, we do know that they differ greatly in the degree to which they can adapt themselves to water of reduced salinity. *Teredo navalis*, which can flourish in water only half as salt as that of the oceans, probably owes its evil reputation to the fact that its tolerance for brackish water enables it to invade estuaries and harbours where the water is commonly less salt than that of the sea outside. It is the common species in the North Sea and comes up the Thames as far as Greenwich. At Plymouth, another species, *Teredo norvagica*, appears to be the commonest, and it will probably be found to prefer salter water. On the other hand, various tropical species ascend rivers, such as the Ganges and the Zambezi, to places where the water is quite fresh. There is even a report that a shipworm occurs in Lake Tanganyika, although no specimens have yet been seen by naturalists.

It should be clear, then, that an accurate determination of the existing species of shipworms and of their conditions of life is of great importance from a strictly practical point of view. How far we are from having this knowledge is perhaps only realised by those who have tried to determine collections of shipworms from different parts of the world. But that is no reason why such knowledge as we have should be neglected. In some recent investigations on the efficiency of certain poisons when used to protect wood against attack by shipworms, the authors do not even trouble to tell us what species of shipworm was used in their experiments.

A study of the shipworm suggests some considerations bearing on current biological theories. For example, like all highly specialised organisms living under peculiar conditions, the shipworms raise in the most striking way the problem of adaptation. The form of the body, the shape of the shell-valves with their file-like rows of teeth and the pivots on which they rock, the disposition of the muscles, the sucker-like foot, the alimentary canal—all these and many other details of structure co-operate to form a mechanism which is unintelligible except as a device for boring into and feeding on wood. The mutation theory of evolution teaches that organisms have evolved by sudden changes of structure which had no relation to the needs of the organism and only an accidental fitness for its mode of life. It is scarcely exaggeration to say that according to this school the shipworm bores into wood and feeds on it because it happens to find itself provided with suitable implements for doing so. If that were all the help to be got from the theory of evolution, it would be better to go back to the doctrine of special creation.

Obituary.

DR. H. B. GUPPY, F.R.S.

HENRY BROUGHAM GUPPY, who died at Martinique on April 23 on the voyage home from Tahiti, began work at a time when a medical training was the usual method of approach to a scientific career. Like other eminent naturalists, he started that career as a surgeon in Her Majesty's Navy. But the inspiration of the islands of the great oceans remained throughout his life as the directing force of his painstaking investigations of the problems relating especially to geographical distribution which they suggested.

In 1878 Dr. Guppy visited the China Seas; but his great opportunity came in 1881, when he was appointed surgeon to H.M.S. *Lark*, which was commissioned for survey work in the western Pacific. Two volumes on the Solomon Islands, published in 1887, contain the results of three years' study on the ethnology, natural history, and geology of this somewhat difficult group, where it was necessary to 'dare a little' in order to learn. The problem of coral-reef formation especially attracted him, and in 1888 he was able to continue his study of the problem on the Keeling-Cocos Islands, a classic locality, as the subsidence-theory held by Darwin was the result of a brief visit to the Islands during the voyage of the *Beagle*. Guppy, who examined all the islands and islets, more than twenty in number, concluded that these small atolls and horse-shoe islands only assume their characteristic form after the island has been thrown up by the waves (see NATURE, 39, 236, 1889). Later, in his physical and geological monograph of Vanua Levu, Fiji (1903), he describes as "one long story of emergence" the building up of the island by reef-formation on a submarine basaltic plateau.

The problem of the stocking of coral islands had interested Dr. Guppy from the first, and between 1890 and 1896 he made a careful study of British plants from the point of view of dispersal by water—a paper on "The River Thames as an Agent in Plant Dispersal" was read at the Linnean Society in 1892. This prepared him for three years' intensive work in Fiji and Hawaii (1896–99), and later on the west coast of South America (1903–4). The fruit of these observations was "Plant Dispersal" ("Observations of a Naturalist in the Pacific," vol. 2, 1906), an eminently suggestive work and a mine of information on the floras, especially littoral, of the islands and eastern shores of the Pacific, and the means of dispersal which have been effective in their formation. General problems are also discussed; and the hypothesis of a great Pacific land-area is dismissed: "We have much to learn before it would be safe to look to hypothetical changes of sea and land to explain difficulties in distribution." The problem of fruit and seed became the *motif* of his work, and his "Studies in Seeds and Fruits; an Investigation with the Balance" (1912), is a study of mechanical and physiological problems bearing on means of dispersal. These were preparatory to his second book on this subject, "Plants, Seeds, and Currents in the West Indies and the Azores" (1917), a record of his personal observations during visits to the Islands, and a valuable contribution to the study of Island floras. The award of the Linnean Medal of the Linnean Society in the same year, and his election shortly after to a fellowship of the Royal Society, were a well-earned recognition of long years of quiet, steady, fruitful work carried out with remarkable singleness of purpose.

A. B. R.

REV. W. A. B. COOLIDGE.

BY the passing away, in his seventy-sixth year, of the Rev. William Augustus Brevoort Coolidge, at the Swiss home which he had built for himself, Châlet Montana, Grindelwald, another famous mountaineer, who carried on the great traditions of the pioneers of the Alps, is removed from our midst. Not merely was he a climber of the very front rank, but the most erudite of the band, possessing a wonderfully complete personal knowledge of the Central European Alps—of their topography and physical geography, their history, and that of the countries in which they are situated. Familiarly and equally conversant with English, French, and German, he was a prolific writer in all three languages, conveying his exceptional knowledge with conciseness yet with fascinating interest. He wrote, for example, the articles on Switzerland in all the three later editions of the "Encyclopædia Britannica," those portions on the geography and history of the country being not only of great value and meticulous accuracy but also of eminent literary merit. Besides his well-known guidebooks (to the Dauphiny Alps, Lepontine Alps, Adula Alps, Mountains of Cogne, and the Bernese Oberland), and his editions of Ball's "Alpine Guide" and Murray's "Handbook of Switzerland," he wrote a most charming book, "The Alps in Nature and History," in which his wide knowledge of the history, antiquities, folk-lore, religious and political development of the playground of Europe is used for our instruction in a truly delightful manner.

Coolidge was a singular combination. An American citizen throughout his life, born near New York and at school in the United States, he became an undergraduate of Exeter College, Oxford, where he took a first in modern history and won the Taylorian scholarship for French. He was afterwards elected to, and retained to the last, a fellowship at Magdalen. Moreover, from 1883 until 1895 he acted as curate at South Hinksey, having taken holy orders. In 1909, however, he removed permanently to Grindelwald, where he had built the Châlet Montana as a home for himself and his priceless library of Alpine literature.

For thirty-five years Coolidge spent the long vacations and some winter ones in climbing and exploration, in his best days accompanied by that wonderful guide, Christian Almer; during this time he climbed practically every peak in the whole of the Swiss, French, and Italian Alps. Elected a member of the Alpine Club in 1870, and an honorary member in 1904, he edited the journal of the Club for the ten years 1880–1889. His greatest claim to fame, however, is in the realm of topographical and physical geography, the whole of his writings on these subjects being characterised by a degree of accuracy which renders them pre-eminently trustworthy and of high permanent value.

A. E. H. TUTTON.

MR. F. S. SPIERS.

BY the death of Mr. Frederick S. Spiers, science loses one who was well known for his ability as an organiser, particularly of affairs related to physical chemistry. Mr. Spiers was born on October 21, 1875. His father was a Dayan or Judge of the Jewish Court. He was educated at the Central Foundation School, Finsbury Technical College, and at the Central Technical College, South Kensington, and obtained the degree of Bachelor of Science (London). He was an associate-member of the Institute of Electrical Engineers and a fellow of the Institute of Physics.

Mr. Spiers was best known for his work as secretary of the Faraday Society, which he assisted to found in 1902. He was an indefatigable organiser. With his help the Society has become one of the most important organisers of scientific discussions in the country. These are noted for the way in which they have brought American, Continental, and British workers together. His ardour was so keen that sometimes it had to be checked owing to the exiguous character of society finances. In 1920 he added to his work that of secretary to the newly founded Institute of Physics, and in this post has shown a like activity and alertness in bringing to the attention of the Board every possible way of amplifying its work. For both of these societies he has proved himself a man whom it will be difficult to replace.

During the War, Mr. Spiers stimulated the formation of a nitrogen products committee of the Faraday Society. As a result of the reports of this committee, in part drafted by him, important researches were carried out by the Munitions Inventions Department. He also organised for the British Science Guild the successful exhibitions of British Scientific Products held in 1917 and 1918. For his work in connexion with the War he received the Order of the British Empire.

Mr. Spiers was well-read in all branches of physical chemistry, but his daily work gave him no opportunity for research. Two papers only appear in his name; one on the electromotive force of Clark cells (*Phil. Mag.*, 1896), and one on contact electricity (*Phil. Mag.*, 1899). His outlook was, however, much wider than his scientific work. He was a Hebrew and Talmudical scholar, and his love for music amounted to a passion. He was keenly interested in all forms of applied art, and at one time was engaged in the production of decorative metal work by electrodeposition. The gold medal and diploma of the Franco-British Exhibition (1908) was awarded for some of this work. The attendance at his funeral was a testimony to the large amount of work that he had done for Jewish education. He was a member of the Jewish Board of Deputies.

His slight body was unable to stand the physical strain of all his activities. On several occasions he had been obliged to rest. For a couple of days before his death he took holiday, but returned on the Friday feeling rather worse than better. In the afternoon (May 21) he was found by one of his office staff leaning back in his chair. He had passed peacefully away.

News and Views.

Limitations of space forbade more than reference in our issue of May 29 to the recent birthdays of Sir Edward A. Sharpey-Schafer, F.R.S., and Sir W. M. Flinders Petrie, F.R.S. Sir Edward Sharpey-Schafer was born in London on June 2, 1850. Assistant professor of physiology in University College, London, from 1874 until 1883, he afterwards became Jodrell professor there, leaving in 1899 to occupy the chair of physiology in the University of Edinburgh. Sir Edward is especially distinguished for the great variety of his work in physiology, for his series of brilliant investigations into the nervous system, for his fruitful exploitation of histological methods, for his valuable discovery of the function of the suprarenal glands, and for the success with which he has applied physiological research to results of practical importance. A leader in physiological and histological inquiries, he has stimulated the prosecution of research, with noteworthy issues, through large numbers of student disciples. Sir Edward's earliest communication to the Royal Society was made so far back as April 3, 1873. The paper, printed in abstract in the *Proceedings*, was entitled "On the Structure of Striped Muscular Fibre"; afterwards the paper appeared in full in the *Philosophical Transactions*, but the title was changed to "On the Minute Structure of the Leg-muscles of the Water-beetle." As general secretary of the British Association from 1895 until 1900, Sir Edward rendered distinct service to science. He was president of that body at the Dundee meeting, held in 1912, delivering an address on the nature, origin, and maintenance of life. At the Oxford gathering of 1894 he was president of the physiological section. Awarded a Royal medal by the Royal Society in 1902, he was Copley medallist in 1924. Sir Edward is a foreign member of the Reale Accademia Nazionale dei Lincei, Rome.

Sir W. M. Flinders Petrie, probably the foremost of living Egyptologists, was born on June 3, 1853, at Charlton, a descendant, on his mother's side, of Capt. Matthew Flinders, R.N., hydrographer and geographer, who is credited with having first suggested the name 'Australia' for the island continent. Sir Flinders, who was educated privately, began archæological survey and research work more than fifty years ago. He was then specially interested in ancient British remains. In 1881 he took up research work in connexion with the pyramids at Gizeh, and thence onwards down to recent days he conducted surveys and excavations in Egypt, exhibiting results which his countrymen have regarded with gratitude and admiration. Between 1888 and 1890 he was at work in the Fayum. In 1894 Sir Flinders founded the Egyptian Research Account, which ultimately became, in reconstruction, the British School of Archæology in Egypt. In 1906 he was awarded the Huxley medal of the Royal Anthropological Institute. Among his numerous publications may be cited "A History of Egypt," "Ten Years' Digging in Egypt," "Religious Life in Ancient Egypt" (1924).

A movement to stimulate the study of pre-Roman Italy, which may be expected to have far-reaching effects on our knowledge of the early cultures of the whole Mediterranean area, has been inaugurated by the National Etruscan Congress, which was held at Florence at the end of April and the beginning of May, when, according to the report of the Milan correspondent which appears in the *Times* of May 25, a number of papers dealing with the language, culture, religion, and antiquities of the Etruscans were read. Prof. Luigi Pareti, professor of ancient history in the University of Florence, supported the theory that the Etruscans arrived in Italy by land and not by sea, traces having been left of their passage across the Alps; and further, that they were descendants of the lake-dwellers of the Emilian region. The problem of the Etruscan language was discussed by Prof. Bartolomeo Nogara and Prof. Trombetti. The latter distinguished three linguistic strata in the Mediterranean basin, of which the Basque is the oldest. The Etruscan he assigned to the second group with the languages of Anatolia. A paper by Prof. Sogliano, which is said to have attracted much attention, supported the view that Pompeii was probably Etruscan and that the Temple of Jove in that city was the Roman substitute for a true tripartite Etruscan temple. Details of Prof. Sogliano's argument will be awaited with much interest in the hope that they will throw further light on the question of the extent of the Etruscan element in Roman culture, and particularly in Roman religion. Committees were appointed to supervise the publication of two series of volumes, one dealing with the culture and institutions of the Etruscans, the other containing monographs on Etruscan centres. At the conclusion of the Congress, visits were paid to the tumulus of Montecalvario at Castellina del Chianti, Vetulonia, Populonia, and Volterra.

The sixth annual report of the British Non-Ferrous Metals Research Association, which has just been received, is a remarkable record of progress. The expenditure on research during the coming year, including certain investigations the direction of which is shared with other bodies, will amount to about 20,000*l*. We are glad to see that the list of new members who have joined the Association during the year includes many large users of non-ferrous metals, such as railway companies and electrical firms, and also manufacturers of scientific instruments, as well as smelters and manufacturers of metals and alloys. The Association owes much to the energy and knowledge of its Director of Research, Dr. R. S. Hutton, while its policy of encouraging research work in the universities and other public institutions, by appointing salaried workers under the direction of scientific men of standing, has proved beneficial to all parties. It has now been found necessary to establish a small central laboratory, accommodation for which has been provided by the University of Birmingham. The report contains an account of the position of the investigations already in progress, and also of the new investigations which have been begun, the latter including work on annealing furnace practice, the working properties of zinc, plumbers' joints, and alloys suitable for use at high temperatures. In the last-mentioned field interesting results have been obtained and published. The report is obtainable from the offices of the Association, 71 Temple Row, Birmingham.

A JOINT committee representing the Royal Society of Edinburgh, the Royal Physical Society, and the Royal Scottish Geographical Society, has made the first award of the Bruce Memorial Prize to Mr. James Mann Wordie, of St. John's College, Cambridge, for his geological and oceanographical work in Arctic and Antarctic regions. Mr. Wordie accompanied the ill-fated Shackleton expedition of 1914–1916 to the Antarctic, and was present with Dr. Bruce in Spitsbergen in 1919 and 1920. Later he led an expedition to Jan Mayen, while in 1923 his attempt to reach the east coast of Greenland was frustrated by heavy pack ice. As a result of his visits to polar regions he has made several valuable contributions to the knowledge of ice-formation at sea, of bottom deposits of Antarctic seas, and of Arctic geology. The Bruce Prize, founded to commemorate the work of Dr. W. S. Bruce, is awarded biennially for notable contributions to science, the outcome of personal visits to polar regions, its object being to stimulate further exploration. The medal (Fig. 1), which forms part of the award, is slightly modified from that designed by Dr. Bruce to commemorate the Scottish National Antarctic Expedition of 1902–1904.

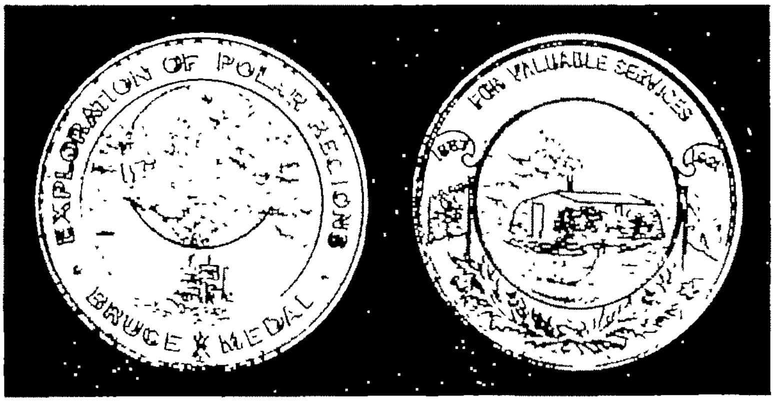

FIG. 1.

THE *Journal of Geophysics and Meteorology*, vol. 1, No. 2, issued under the editorship of the late Dr. Friedmann, former Director of the Central Physical Observatory at Leningrad, contains twelve papers, all of which are in Russian, save one, which is in German (with a Russian summary); but short summaries of the Russian papers are given, six in English, one in French, and four in German. The contents relate mainly to meteorology, but a useful summary of magnetic results obtained at Pavlovsk (now to be known as Slutzk) is included; these are for the years 1912–1923, for which Pavlovsk data have not hitherto been published, the Annales of the Central Physical Observatory being temporarily suspended. The diurnal inequalities of each of the three elements of magnetic force are given in the mean for each of the twelve years: the seasonal variations of the diurnal inequalities are not indicated. An interesting article by Kurt Wegener (Hamburg) deals with the artificial production of rain, describing an attempt in this direction and the reasons why failure in this and all such attempts must be expected.

DURING the present century there have been several great volcanic eruptions in Japan, especially those of the Usu-san (Hokkaido) in 1910, the Asamayama (central Japan) in 1908–14, and the Sakurajima (southern Japan) in 1914. These are all well-known active volcanoes. The great eruption of Tokachi in Hokkaido that began on May 24 took place, however, from a volcano that was supposed to be extinct, and from a crater that has been occupied by a lake within historical times. The first explosion ejected the water from this lake. Later in the day there were two other explosions, accompanied or followed by an outflow of lava. By the last explosion part of the wall of the crater was blown away. Several hamlets and the greater part of the town of Furyono have been destroyed, and 900 persons are reported to have been killed by floods and lava-streams.

ON his return from a tour of British West Africa, Mr. Ormsby-Gore, Under-Secretary for the Colonies, gave some of his impressions to a representative of the *Times*. The Gold Coast Colony has made remarkable progress during the last five years, due largely to the great development of motor roads and transport facilities. Work is also proceeding on the construction of a modern deep-water harbour at Takoradi, which will be of great value in the two staple trades, cocoa and manganese-ore. Nigeria shows great prosperity and, with a large surplus balance in the past year, is justified in proceeding with the development of its transport. The present road system is entirely inadequate and a serious hindrance to the development of cotton growing. Mr. Ormsby-Gore will outline in his report a continuous programme of railway construction of anything from 100 to 150 miles a year for the next five years. The provinces of Sikaso, Zaria, and Kano alone may be expected to increase their annual cotton output to 250,000,000 bales of 400 lb. each of a fine type of American cotton. When a new type of cotton, on which the Agricultural Department is now experimenting, is produced, the middle belt of Nigeria will yield also an important crop of export cotton. In conclusion, Mr. Ormsby-Gore expresses himself as strongly opposed to any extension of the length of residence of European officials in West

Africa. The leading commercial firms are tending to reduce rather than to extend the period of stay of their officials.

THE key idea of Prof. J. McLean Thompson's lecture before the Royal Society of Arts upon "The Sea Transport and Storage of Fruit," published in the Society's journal for February 26, appears to be that the fruit carried to Great Britain has to be regarded as a 'living passenger.' Thus regarded, it is desirable to harvest and keep it under such conditions before shipping, that the fruit has ripened normally, and then in transit, if conditions are suitably adjusted, it may be possible, without the expense of cold storage methods, to keep it at that condition of restful dormancy which often seems to follow in living fruit and seed upon the attainment of maturity. Prof. McLean Thompson was apparently not in a position to discuss methods by which, under commercial conditions of storage, ripe fruit, of apples and oranges, has thus been kept in good condition for several months without resort to cold storage. He makes, however, a plea for further endowment of research at the great ports of Britain at which our imported food supplies enter, in order to enable a more thorough exploration of the methods, individual to every fruit, by which he hopes that ultimately we may succeed in transporting and storing suitably mature fruit by a treatment which will be based on a recognition of its needs as a living organism at a certain stage of existence. The chairman, Sir Halford John Mackinder, endorsed Prof. McLean Thompson's plea for research, but added the advice to the commercial interests involved that they should recruit from universities and colleges scientific practitioners prepared to apply scientific knowledge under commercial conditions to the workaday problems presented by the 'rough and tumble of trade' conditions under which shipping, transport and storage of fruit must take place.

IN the annual report of the Rockefeller Foundation for 1924 Dr. George Vincent, the president, surveys the activities of the Foundation for that year. These include a contribution of 350,000 dollars towards the publishing of an international journal for abstracts of the biological sciences, reports on the progress of medical education in various countries, and contributions for travelling fellowships. Grants were made to various medical schools in Great Britain, Canada, the United States, and China, funds provided for nursing education at Yale University and other schools and hospitals, campaigns organised against yellow fever, malaria, and hookworm disease, contributions made to the Health Section of the League of Nations towards epidemiological intelligence and study tours arranged for health officers, and assistance given to mental hygiene projects in the United States and Canada. The income of the Foundation in 1924 amounted to 8,191,506 dollars, and the disbursements to 7,288,822 dollars. The report also contains reports of the directors of sections, summaries of the work being carried out in various lands, and lists of publications of members and others directly associated with projects in which the Board participated.

IT is reported that archæological and historical discoveries of considerable importance have been made by Sir Aurel Stein, who has been engaged during the last two months on a tour of investigation in the Upper Swat on the Indian frontier. This area abounds in stupas, rock-carved reliefs, and other Buddhist remains, and for many years it had been anticipated that, given settled conditions, it would prove a profitable field for archæological exploration. That its strategic importance has long been recognised is indicated by the strongholds of old-time chieftains which abound, and it is an examination of the topographical features in this connexion that has led Sir Aurel Stein to a conclusion of very considerable historical interest. According to a dispatch from the Simla correspondent of the *Times* which appears in the issue of May 27, Sir Aurel believes that he has succeeded in identifying in a part of the Swat hills known as Torwal the site of Aornos, the fortress described by Arrian which Alexander captured in 327 B.C. This is usually considered to be the greatest achievement of his remarkable march on India. The topographical features of this suggested site appear to correspond with the description given by Arrian. Sir Aurel Stein himself showed some years ago that the suggested identification of Aornos with Mahaban was untenable on the ground that the summit of that mountain did not correspond with the extensive plateau which figures in the Greek account. The probability that Alexander's march to India led him to Bajaur and the Swat valley has now been greatly strengthened. It is further reported that Sir Aurel Stein has discovered two Buddhist shrines mentioned by Chinese pilgrims, a stone bearing the miraculous footprints of Buddha and a boulder with an impression of Buddha's drying clothes, which shows signs of continued local worship.

PROF. G. H. HARDY, Savilian professor of geometry in the University of Oxford, has been elected a corresponding member of the Vienna Academy of Sciences.

THE following have been elected foreign associates of the National Academy of Sciences of the United States of America: Prof. Jacques Hadamard, professor of analysis at the Ecole Polytechnique, Paris; Prof. Richard Willstätter, formerly professor of chemistry at the University of Munich; Sir Frank Dyson, Astronomer Royal, Great Britain; Prof. Max Planck, director of the Institute of Theoretical Physics at the University of Berlin.

THE thirty-first annual congress of the South-Eastern Union of Scientific Societies will be held at Colchester on June 9–12 under the presidency of Mr. Reginald A. Smith, of the Department of British and Medieval Antiquities, British Museum. The presidential address, "Essex in Pre-Saxon Times," will be delivered on June 9; other papers promised include "The Plant Communities of the Seashore," by Dr. E. J. Salisbury, "Dr. Wm. Gilberd, of Colchester, Author of 'De Magnete,'" by Mr. C. E.

Benham, "Some Curious Aspects of Evolution," by Mr. E. C. Stuart Baker, and "The Correlation of the Lower Palæolithic," by Mr. S. Hazzledine Warren

We much regret that, by an oversight, the name of Ives Delage was included in the column of Contemporary Birthdays in our issue of May 8. Prof. Delage died on October 8, 1920.

Erratum. Nature of May 22, p. 720, col. 1. In formula at bottom of column, for "$\cos 2/\phi$" read "$\cos \phi/2$."

Applications are invited for the following appointments, on or before the dates mentioned:—A lecturer in mechanical and civil engineering at Loughborough College—The Registrar (June 7). An assistant lecturer and demonstrator in chemistry and an assistant lecturer and demonstrator in engineering at the University College of South Wales and Monmouthshire—The Registrar, University College, Cardiff (June 14). A reader in mechanical engineering at King's College, Strand—The Academic Registrar, University of London, South Kensington, S.W.7 (June 17). A professor of botany at the University College of Wales, Aberystwyth—The Secretary (June 19). A professor of Arabic, Persian, and Hindustani at Trinity College, Dublin—The Secretary (June 21). A professor of chemistry and assaying at the Indian School of Mines, Dhanbad—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (June 21). A junior technical officer for development work in connexion with instruments and small precision apparatus—The Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (June 26, quoting references No. A. 95). A curator of the Colchester and Essex Museum, Colchester—The Town Clerk, Town Hall, Colchester (June 28). A librarian for the University of Aberdeen—The Secretary, The University, Aberdeen (June 30). An assistant in the industrial engineering division and an assistant in the science library of the Science Museum, South Kensington—The Director and Secretary, Science Museum, South Kensington, S.W.7 (June 30). A lecturer in zoology, with special reference to the comparative anatomy and embryology of vertebrates, in the University of Edinburgh—The Secretary to the University (July 23). A temporary junior assistant (metallurgist) under the directorate of metallurgical research, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18. Instructor lieutenants in the Royal Navy—The Adviser on Education, Admiralty, Whitehall, S.W.1. A lecturer in botany at the Birmingham Municipal Technical School—The Principal.

Our Astronomical Column.

Comets.—Ensor's Comet maintained the anomalous position of its tail for a full month. On March 16 the tail was 80° from the prolongation of the radius vector from the sun; on April 3, nearly 70°; and on April 13, about 60°. Since matter expelled from the head under solar repulsion would initially proceed along the radius vector, it would seem that the tail was not due to such repulsion: it is not easy to explain its direction, for there was no definite nucleus that could be regarded as a centre of repulsion. On April 13 the comet had sunk to magnitude 17 and was not followed for longer.

Finlay's periodic comet is due to return to perihelion about June 23. It will not be very well placed for observation at this return, being low in the morning sky just before dawn.

The following ephemeris for 0^h is from the B.A.A. Handbook:

	R.A.	N. Decl.
June 11.	2^h $11{\cdot}5^m$	11° 6′
19.	2 46·8	14 18
27.	3 21·9	17 4

It will be better placed in July, owing to its northward motion. It was last seen in 1919.

Comet Pons-Winnecke will return to perihelion in June 1927. An ephemeris by Mr. F. E. Seagrave indicates that it will approach the earth within 4½ million miles on June 26, when its horizontal parallax will be 190″. A well-defined object at that distance would serve admirably for deducing the solar parallax, but it is rather too much to expect that the comet will have a sufficiently definite nucleus for this purpose.

Minor Planets.—A note by B. Asplind in *Astr. Nach.* No. 5442 demonstrates that the hitherto unidentified planets Simeis 59 and Simeis 60, discovered in 1916, are identical respectively with 1029 (discovered last year and named La Plata) and with 962 (discovered in 1921). This identification affords material for a great improvement in the orbit elements of these planets. The following planets have been recently named: 829 Academia, 830 Petropolitana, 917 Lyka, 962 Aslog, 984 Gretia, 1026 Ingrid.

The Spectrohelioscope.—A description of this instrument by Dr. Hale has already appeared in the *Proceedings of the National Academy of Sciences*, 10, 361, 1924, and in Nature, 114, 628, 1924. In the April number, 1926, of the *Publications of the Astronomical Society of the Pacific*, Dr. Hale gives other details of his instrument, which is now permanently set up at his new solar laboratory in Pasadena. Recent observations indicate its wide scope as an important instrument of research and not merely as a very useful scouting auxiliary of the spectroheliograph. The observations are made visually with the hydrogen line *Hα*. Besides the prominences around the sun's limb, it is usually possible to see prominences projected on the disc as dark areas, and bright or dark flocculi, including hydrogen vortices around sunspots. In addition, by setting the second slit on different parts of the *Hα* line, on occasions when there are great line distortions due to high radial velocities, the instrument admits of observations being made in rapid succession of, for example, a brilliant eruption on the violet side of the line and, on the red side, of a dark absorbing mass descending rapidly into the hydrogen vortex. Dr. Hale suggests the possibility of a photographic attachment for reproduction of these rapid changes in the form of moving pictures. An account is given of phenomena, accompanying the very large sunspot of January 1926, and another spot in February, which could be seen with the spectrohelioscope. The author describes modifications he is introducing into the construction of an improved instrument for precision measures of some of these solar phenomena, which it is now possible to study in great detail. We hope to publish shortly an illustrated account of the instrument and of Dr. Hale's recent work with it.

Research Items.

THE SOCIAL ORGANISATION OF THE POMO INDIAN.—A detailed descriptive study of a concrete example of social organisation in its actual working is given by Mr. Edward Winslow Gifford in his "Clear Lake Pomo Society," which is published by the University of California as vol. 18, No. 2, of the *Publications in American Archæology and Ethnology*. This is not an abstract analysis, but is an account of the households, their members, and their affinities one to another, familial and social, as well as their occupations and their activities, ceremonial and other, in the Eastern Pomo village of Cigom on the eastern shore of Clear Lake, Lake County, California. A census by a former inhabitant made in 1919 totalled 235 individuals, 25 per cent hailing from neighbouring villages. These 'foreigners' residing in the village invariably do so because of marriage. All but two of the twenty living-houses were occupied by two or more families, the number of entrances and the number of fires in each house corresponding to the number of families The nucleus of the family was a man, his one wife (monogyny being the rule), and their offspring In size the family group varied from one to ten, but the average was four and a half individuals. Of blood relationships noted, 36 were matrilineal, 16 patrilineal, 5 were neutral, and one unknown. In half the cases the newly-married couple lived with the husband's father, in half with the bride's father. The chieftainship was hereditary, each chief heading a group related to him, usually through females, but there was no village or supreme chief. Among the Eastern Pomo, of eight cases of succession to the chieftainship, four were from the mother's brother to sister's son, one doubtfully so, two from brother to brother, and one from father to son. Among the Northern Pomo, of three cases two were from father to son, and one from mother's brother to sister's son. There was an occasional custom of naming a child for a grandparent, more frequently paternal than maternal.

THE TORADJA OF CENTRAL CELEBES.—Dr. Walter Kaudern, in the second part of his "Ethnographical Studies in Celebes" (Goteborg: Elanders Boktryckeri Aktiebolag), deals with the migrations of the Toradja. It is generally agreed that the Toradja are not the aboriginal inhabitants of Central Celebes. Nor are they a uniform race: two distinctly different types are found, the majority of the people being of a rather dark brown type with round broad face and short broad nose; while the less numerous light brown type has a comparatively oval face, the nose being long and narrow, straight or slightly curved. Apparently the two types were already mixed when they reached Central Celebes. Taking the three big Toradja groups, the Paloe, the Koro, and the Poso Toradja, and basing investigation on accounts of migrations in historic times, legends of prehistoric migrations, inferences from the direction of the home of departed spirits, and cultural, linguistic, and other relations, it would appear that the migrations proceeded along two principal routes, both beginning in the south-east in the tract of Malili on the coast of the Bone Gulf. One went to the north-west to the regions west of Lake Poso, the other went first almost due north and then sent out branches to the north-east and north-west. The former route was that of the Koro Toradja, the latter that of the Poso and Paloe Toradja. The latter only formed part of the easterly stream of people, and moving on in front of the Poso Toradja, spread farther to the north and north-west. Present knowledge is not sufficient to justify any statement as to the kinship of Poso and Paloe Toradja, though there appears to be no essential difference. These migrations were still going on in the eighteenth century. Their cause is obscure; it may have been over-population of the cultivated areas; and attempts to fly from epidemics, of which there is legendary record, may have been a contributory cause.

FOOD OF TERNS.—Dr. W. E. Collinge gives an account (Blakeney Point Publication, No. 26) of his investigation of the food of terns, undertaken at the invitation of the National Trust, in consequence of numerous complaints by local fishermen that these birds were destroying the inshore industry in flat fish. The author found that the food of the terns in the vicinity of Blakeney Point consisted of 40·32 per cent. of fish, of which 25·48 per cent. was food fishes and 14·84 per cent. sandeels. The food fishes were entirely whiting, haddock, herring, and whitebait, and in no single instance was there any trace of flat fish in the stomach contents. He concludes, therefore, that any recent scarcity of flat fish in the Blakeney Point area can in no way be attributable to the terns living there. This vindication should go a long way towards reassuring the local fishermen and enlisting their goodwill in the preservation of this nesting site.

A MALELESS RACE OF DAPHNIA WHICH PRODUCES EPHIPPIAL EGGS.—Dr A. M. Banta (*Zeitschr. f. induktive Abst. und Vererbungslehre*, Bd. 40, 1925) describes a maleless race of *Daphnia pulex* in which nevertheless the characteristic ephippial or 'winter' eggs are produced and developed without fertilisation. The author notes the characters by which this race differs from other types of *D. pulex*. Males have not been found in this race, in spite of long observations on the stock and experimental efforts to cause their production. The usual parthenogenetic ('summer') and ephippial ('winter') eggs are produced, and in every phase of their ovarian and post-ovarian development resemble the corresponding two types of eggs produced by other Daphnidæ, and their homology with these is beyond doubt. These ephippial eggs—which the author suggests should be called pseudo-sexual eggs—readily hatch without fertilisation. This race is possibly identical with the race found in Spitsbergen, in which similar behaviour has been suspected. The author suggests that the race represents a possible step in advance in the evolution of Cladocera in that (1) it has the ephippial egg adapting it to habitats in which periods of drought or low temperature preclude the survival of active Cladocera or of the usual parthenogenetic eggs, and that (2) it possesses the obvious advantage that the non-occurrence of males leaves every individual productive of eggs of the type called forth by the particular temporary conditions of the environment.

CHANGES IN THE BOTTOM FAUNA OF ILLINOIS RIVER AND PEORIA LAKE.—R. E. Richardson (*Bull. Illinois Nat. Hist. Survey*, vol. 15, 1925) records the changes in the bottom fauna of Lake Peoria from 1920 to 1922. In a former paper it was shown that during the six or seven years preceding 1920 there had been an almost complete extermination of the older normal bottom fauna over a stretch of about 90 miles of the Illinois River, including Peoria Lake, and practically complete oxygen exhaustion. This was associated with a large increase (about eight times) in the animals slaughtered in the Chicago stockyards between 1914 and 1918, with a corresponding increase in the waste matter entering the sanitary canal which discharges into the Illinois River. Heavy mortality among the fresh-water snails occurred; in August 1917 dead snails acres in extent were seen floating down the river past Peoria and Havana. The present paper indicates a slight though measurable improvement in the condition of the bottom fauna in the two years 1920–22, but the increase in kinds was almost wholly confined to the group of tolerant Sphæriid snails which survived the destruction of 1915–18. The extension of the range of these snails was parallel to the tremendous increase in numbers of tubificid worms, which ranged so high as 69,000 per square yard opposite Rome in August 1922 and is taken as an indicator of bad bottom. The material was collected by a Petersen bottom sampler. Species that have disappeared from Peoria Lake since 1914 include all but three or four of a total of more than 40 species of fresh-water mussels, all the snails of the family Amnicolidæ, and all but one species of the formerly important and conspicuous family Viviparidæ. The author gives a list of the missing species in the same Bulletin, Article 6.

THE ABSENCE OF AN INNATE SEXUAL CYCLE IN CLADOCERA.—Weismann's view that in Cladocera there is an innate sexual cycle quite independent of environmental influences is contradicted by observations by Dr. A. M. Banta (*Amer. Natur.*, vol. 59, 1925), which indicate that stock recently derived from fertilised eggs of *Moina macrocopa* is neither less nor more prone to produce males, under appropriate environmental conditions, than stock which has descended 300 generations since last undergoing sexual reproduction.

THE SYMBIOSIS OF A FERN AND AN ALGA.—Alfred Limberger records some observations (*Sitzungsber. Akad. der Wissensch*, Wien, Abt. I. 143, pp. 1-6) which make very much more precise our knowledge of the relation existing between the little water fern Azolla and the blue-green Alga Anabæna, which is always found in small cavities in the leaves There are four species of Azolla distributed over different parts of the globe, but in all cases this blue-green alga is associated with the fern; the intimacy of the relation thus established between two plants of very different type has been a matter of speculation. Limberger succeeded, by cultivating Azolla over winter on fairly dry soil in a cold greenhouse, in obtaining a stock of the fern quite free from the blue-green alga. So long as this plant was kept growing under normal conditions next summer, it grew perfectly well and no significant difference could be noted between the alga-infested and the alga-free cultures of the fern. Curiously enough, with two different species of Azolla thus freed from Anabæna, another blue-green alga, Oscillatoria, was found infesting the fern though not entering the leaf cavity, as if the fronds of this little fern had some definite chemotactic attraction for blue-green Algæ or special facilities for their nutrition. With the algæ-free Azolla, Limberger repeated some previous cultures of the plant in food solution with and without nitrogen. It was now found that the fern free from Anabæna died or grew very poorly in nitrogen-free solutions, whilst the fern with Alga in the leaf cavities flourished. Definite evidence seems thus to be provided for the possibility of nitrogen fixation by the alga, which under unfavourable conditions of growth is utilised by the fern. When other sources of nitrogen are present, the alga seems of little use to the fern, in fact may grow so excessively as to become a nuisance.

AN UPPER CRETACEOUS FLORA.—Under the title "The Flora of the Ripley Formation," Edward Wilder Berry describes, in *Professional Paper* 136 of the United States Geological Survey, an Upper Cretaceous flora of some 135 species. The total number of genera represented is 71; of these a supposed Alga Halymenites, and a form referred to Selaginella, are of doubtful botanic affinity; in addition there are six species of ferns, 9 gymnosperms, 9 monocotyledons, and 105 dicotyledons, of which only 10 belong to sympetalous genera. While nearly all the ferns and conifers found appear to have a wide distribution "as befits their ancient lineage," most of the dicotyledons are recorded for this Ripley formation only, and of the 28 per cent. that occur elsewhere, most of them are only recorded from Greenland, which is perhaps the place of origin of the Upper Cretaceous flora of North America. Sixteen of the Angiosperm genera recorded have not been recognised in post-Cretaceous deposits, and the author points out that the contrast between Upper Cretaceous and Eocene floras is usually under-estimated, in part owing to the habit of laying stress upon the coming of the Angiosperms in Upper Cretaceous time, which it is "the fashion to picture—as a sudden and overwhelming event."

THE MICROSCOPIC STRUCTURE OF COAL.—A most interesting lecture on this subject, given before the Royal Society of Arts by Dr. Reinhardt Thiessen of the United States Bureau of Mines, is published in the Society's journal for April 23. After a brief introductory statement of the manner in which various kinds of coals may be pictured as arising progressively from plant remains such as may accumulate under the conditions of the peat bog, where vegetable decay is very slow and in the lower layers of the peat has practically ceased, Dr. Thiessen proceeded to analyse the various types of appearance found in bituminous coals, the clarain, vitrain, fusain, etc., of British writers, into terms of plant remains recognisable by microscopic study. Under the microscope Dr. Thiessen recognises two main classes of constituent: (1) the compressed woody and fibrous fragments of plants, the anthraxylon, and (2) indefinite masses made up of finely macerated plant material, macerated wood, cuticle, spores, etc., grouped under the term 'attritus.' From this lecture it would appear that the methods of study of the coal mining geologist and the palæobotanists are converging at present in their application of new methods of technique with the aid of the microscope to reveal the minute structure of the compressed fragments of plants embedded in the rocks (Harris, NATURE, May 8, 1926, p. 670).

COLORADO RIVER.—The remarkable characteristics of the Colorado River, U.S.A., form the subject of Water Supply Paper No. 556 issued by the U.S. Geological Survey. The river is of exceptional value for irrigation and water power, as it combines in proper sequence for full development and use a large quantity of water, great concentrations of fall, reservoir sites for the control of flow, sites for power plants, and several million acres of irrigable land below the district in which power can be developed. The drainage basin comprises 244,000 square miles and covers parts of seven States. The most urgent need of the basin is flood protection for cities, towns, and large irrigated areas near Yuma and in the Imperial Valley. It is stated in the report that property to the value of one hundred million dollars and the prosperity of many thousands of inhabitants on both sides of the international boundary between the United States and Mexico are seriously menaced by the lack of efficient control works, and this menace is increasing yearly, the maintenance of banks and levees becoming more difficult and costly as time goes on. Mr. La Rue, the writer of the report, has made systematic inspection of the basin since 1914, and the information collected, including geological diagrams and photographs, is intended as a basis for outlining a comprehensive scheme of development for the river and for selection of a site for earliest development.

AN ANCIENT SPECIMEN OF URANINITE.—Another estimate of the age of the earth's crust has been formed from the examination of a sample of uranium lead found in South Dakota. The results of this investigation, carried out by T. W. Richards and L. P. Hall, are published in the *Journal of the American Chemical Society* for March 1926. The atomic weight, corrected for the influence of a known thorium content, is 206·02. Since the sample is nearly pure uranium lead, its age is about $1·5 \times 10^9$ years.

PENETRATING COSMIC RADIATION.—In a recent communication to NATURE, M. L. N. Bogoiavlensky, writing from Leningrad, gives the results of some investigations made by him in the Caucasus, in a region of radium deposits, on "Highly Penetrating Rays of the Earth." A close survey has been made of the penetrating radiation in an area of about 11,000 square yards, traversed by cracks in travertin, containing radio-active material. The results when plotted give equi-radiation lines roughly parallel to the cracks. A measure of the penetrability of the radiation was obtained by the use of lead screens *beneath* the electrometer at the various observing stations, indicating γ-radiation from a radio-active material at 22 stations out of 92. At the other 70 stations a more penetrating radiation only was observed. The minimum screened values varied, showing a variation (even in this small area) of the ionisation due to a more penetrating radiation than that from radium. At these stations the use of side screens was without effect. Experiments in other places over soil of low radium content gave varying values for the ionisation and showed also a very small absorption of the radiation by lead screens. M. Bogoiavlensky's results would appear to supplement those of Hoffmann, who explains the effects by the existence of a more penetrating radiation from radium than the previously known hardest rays from radium C. Against this, Hess has pointed out that the result is explicable on the assumption that the cosmic rays do not appreciably ionise a gas, but only the softer secondary, etc., rays due to these.

SECONDARY RADIATION FROM THE SURFACE OF THE EARTH.—In the *Physikalische Zeitschrift* (March 15, 1926) Hess discusses the very penetrating 'cosmic' radiation and the difference between the absorption co-efficients in water obtained by Kohlhörster and by Millikan. He takes exception to the use of lead as a screen for absorption measurements on account of the appreciable radium content of different lead samples, and for this reason questions Hoffmann's deduction that the penetrating radiation at sea level can be wholly explained as the result of known radio-active elements. Hess points out that this explanation will not fit the fact that the ionisation first decreases and then increases with increasing distance above the earth. He points out further that the key to the results obtained by Hoffmann and by Behounek may lie in the circumstance that the 'cosmic' radiation experiences the Compton effect on scattering, with consequent formation of softer γ-rays, if it is a fact that the ionisation by the softer derived radiation is much greater than that of the primary rays. Already, in 1912, Hess suggested that a part of the differences between measurements of penetrating radiation on land and water might be referred to differences in the secondary radiation from the surfaces.

THE CRYSTAL STRUCTURE OF CATECHOL.—The crystal structure of catechol has been determined by W. A. Caspari, using the rotating crystal method with the three crystallographic axes as rotation axes. Diagrams obtained by projection of the photographs on paper are given in the *Journal of the Chemical Society* for March 1926. From these the number of molecules per unit cell has been deduced as eight, and their manner of disposition is discussed.

NUTRITIVE VALUE OF SYNTHETIC FATS.—From experiments carried out with albino rats and described in the *Proceedings of the Imperial Academy of Japan* for January 1926, the approximate nutritive values of synthetic fats containing fatty acids of an uneven number of carbon atoms have been tabulated. As a check, the food values of fats containing fatty acids of an even carbon atom content were determined under similar conditions. No sharp line of division could be drawn between these two classes of fats as regards their nutritive value.

INTENSITY OF ILLUMINATION AND PHOTOCHEMICAL CHANGE.—Berthoud and Bellenot's experiments on the effect of the intensity of illumination on the velocity of the interaction of iodine and potassium oxalate have been repeated by F. Briers, D. L. Chapman, and E. Walters to test their theory, and their conclusions are presented in the *Journal of the Chemical Society* for March 1926. They found that the rate of reaction is proportional to the intensity of illumination and not to the square root, as found by Berthoud and Bellenot. It was noticed that the reaction continued after shutting off the light, and values for the life of a hypothetical catalyst are given.

ENERGY RELATIONS OF SOUND WAVES.—A very interesting paper giving measurements in connexion with acoustical apparatus was read by B. S. Cohen to the Institution of Electrical Engineers on April 29. The researches were carried out in the laboratories of the General Post Office. A knowledge of the efficiency of telephone lines and apparatus is necessary in telephone engineering, and much of this knowledge is of equal importance to the radio engineer. The frequency of the waves used in speech extends from a frequency of about 100 to a frequency of about 6000, a range of six octaves. By means of a suitable electric filter it has been proved that good quality speech can be transmitted when all waves having frequencies exceeding 2500 are blocked out. Practically perfect speech is obtained when only waves the frequencies of which exceed 5000 are blocked out. To get perfect musical transmission, frequencies up to about 10,000 have to be transmitted. With a normal voice the average speech energy entering a telephone transmitter is about 100 ergs per second. A good violin gave a fairly uniform output of 600 ergs per second at a frequency between 192 and 1300. A male voice intoning twelve vowel sounds at conversational loudness with a fundamental of frequency 129 had an output of 56 ergs per second, and a female voice intoning a vowel with a fundamental of 129 had an output of 40 ergs per second at conversational volume. The characteristics of the ear have been investigated by American engineers. The threshold of audibility for a normal ear varies from an acoustical pressure of 0·15 dyne per square cm. at 60 frequency to 0·001 dyne per sq. cm. at 1000 frequency. Between 1000 and 4000 frequency the sensitivity remains approximately constant at 0·001 dyne per sq. cm. Many methods are suggested for measuring the acoustical efficiency of apparatus, and some useful curves are given.

The Abyssinian Sources of the Nile.[1]

IN pursuance of the policy to carry out a complete investigation of the hydrological conditions existing in the basin of the Upper Nile, the Egyptian Government has recently published the report of an expedition to the Equatorial Lake Plateau, and has followed this up with the present volume which deals with Lake Tana in Abyssinia, whence the Blue Nile flows to the Sudan and Egypt.

The importance of this lake in the schemes for the control of the Nile waters, and protection from very low floods, depends on the practicability of utilising it, and the Albert lake similarly, for storing up the water of an abundant rainy season to supplement the supply of a year of meagre rainfall.

This report describes the work which was carried on from the spring of 1920 to the summer of the following year by Dr G. W. Grabham, Government Geologist of the Sudan, and Mr. R. P. Black, of the Physical Department of Egypt. This was the third occasion on which the Abyssinian Government had given permission for studies of the lake and the Blue Nile's outlet from it to be carried out; the earlier ones having been made by Mr. C. E. Dupuis in 1903, and by Mr. R. B. Buckley in 1916. On the present occasion, however, the work was much more detailed and complete, since the observations of levels and discharges were carried on until May 1924, thus providing discharge data over a period of 34 months, including three flood periods.

The southern shore of the lake, where the Blue Nile leaves it, was the part which the expedition examined and surveyed in detail, and they arrived at the conclusion that the lake is of recent formation, owing its origin to a lava flow from the west which has dammed back the drainage of the shallow valley in which the lake now lies. This lava lying on the plateau basalts of Abyssinia furnishes a solid foundation for the construction of a regulator to control the discharge from the lake. In order that the lands and buildings which lie near the lake should not be inundated as the result of controlling the outflow, a regulator is proposed which will allow regulation through a range of three metres below the present normal lake level. This would provide a reserve supply of about 3500 million cubic metres of water to supplement the supply of Egypt in years of abnormally low flood.

The meteorology and geology of the plateau in the neighbourhood of the lake were carefully studied, and especial attention was paid to evaporation, which is an important factor on large lakes, and Lake Tana has an area of 3060 square kilometres. Observations carried out both with evaporimeters on land and by means of tanks floating on the lake, resulted in determining the rate of evaporation to range from 1·5 mm. per day in August to 6·0 mm. in April, giving a total loss of 1480 mm. in the year. The volume discharged at the outlet varied from about 10 cubic metres per second at the end of the dry season to about 500 cubic metres per second when the lake was at its highest level in September. This amount represents a very small fraction of the flood of the Nile at Assuan, in fact less than one-fiftieth of the volume entering Egypt at the highest stage of the flood; so from this point of view Lake Tana's contribution is unimportant; but if by means of a regulator the volume corresponding to a three metres change of level, 3500 millions of cubic metres, were available in the case of an exceptionally small low-stage supply, the situation in Egypt would be greatly improved.

The cost of the necessary works is put very approximately at about two and a half million sterling, but this might be materially increased if much road-making up to the lake should be necessary.

A large amount of information is given on the country and the people inhabiting the region near the lake, and also on the various routes which lead up to it. The work was carried out in somewhat difficult circumstances, since the surveying, levelling, and measurement of discharges aroused much suspicion locally, although the party were furnished with letters of authority by the Abyssinian authorities at Addis Abeba; but with tact and patience this difficulty was overcome and the work was successfully brought to a satisfactory conclusion.

The report contains sixteen hydrographical and meteorological diagrams of much interest besides maps of the lake, and the Blue Nile outlet, while thirty-four very fine photographs give an excellent presentation of the country, the lake shore, and the gorge of the Blue Nile near the lake.

H. G. L.

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[1] Ministry of Public Works, Egypt. Report of the Mission to Lake Tana, 1920–21. By G. W. Grabham and R. P. Black. Pp. xx+208. (Cairo: Government Publications Office, 1925.)

International Biology.

IN an interesting address on "International Biology" delivered at the third Pan-American Scientific Congress held at Lima, Peru, a little over a year ago, and recently published (*Bull. Pan-American Union*, Dec. 1925), Prof. Vernon Kellogg cited a number of cases in which it is, or would be, of obvious advantage to have international action in matters of biological science. The almost complete stamping out of yellow fever in the western hemisphere is one of the most striking results of co-operative work—a conspicuous example of useful international biology, for all the fighting of disease and the developing of public health activities rest ultimately on biological research and on the applications of the results of such research.

The successful control of insect pests of crops affords another example, for Prof. Kellogg points out that of the fifty most serious insect enemies of crops, orchards, and stock in the United States, more than three-fifths are immigrants, *e.g.* the Hessian fly, flour and grain moths, ox warbles, and the horn fly from Europe, the cotton boll weevil from Mexico, the San José scale from Japan. But he also pointed out that the grape phylloxera went from New England to France, where more than 2,000,000 acres of vineyards were destroyed before a remedy was found, and that the Colorado potato beetle has established itself in south-eastern France and is threatening to invade the potato fields of Germany. The exchange of insects is, however, fortunately not limited to injurious ones. In its native country an injurious insect is more or less kept in check by predaceous and parasitic insect enemies, and it is now a well-recognised part of economic entomological practice to send experts to foreign countries to search for and bring back the native enemies of important insect pest immigrants—there is thus an international exchange of 'good bugs.'

Similarly, there is the exchange of good plants, and Prof. Kellogg points out that a number of regions of the United States owe their present prosperity, and in some cases even the very existence of their agriculture, to the intentional importation of some crop plant from a distant part of the world, *e.g.* the date oases of California and Arizona, the durum wheat areas of the great plains, the rice fields of California and Texas. Prof. Kellogg remarked that the plants which grow in the colder regions of the earth are mostly species which have crept out of the tropics, adapting themselves as they have spread north and south to the conditions of colder climates, and he thinks there are probably ten times as many undiscovered useful plants remaining in the tropics as are to be found in the colder regions. The plant breeders of the United States are striving to select the hardiest of these tropical species and to adapt them for cultivation as far north as they will grow.

The conservation of migrating birds of practical and æsthetic value affords another example of useful international biology, for the extensive migrations of these birds require that conservation shall hold good in the extent of their range. The rational use and protection of the animals of the oceans that wash the coasts of North and South America was also cited, *e.g.* the fur seals of the Pacific were saved from extinction by international agreements made in 1911 between Great Britain, Russia, Japan, and the United States. But the sperm whale is passing, and unless international action is taken it will soon be gone.

Finally, Prof. Kellogg directed attention to the international exchange of human beings—the matter of emigration and immigration with all the perplexing biological problems inherent to it. While many people consider the economic and political significance of the problem, it is incidental to and determined by the biological results. The National Research Council of the United States has a special committee at work on "the scientific problems of human migrations," for it is fully realised that the strength of the nation rests at bottom on the kind of heredity possessed by the people of the nation—it rests at bottom on biological factors

Petroleum in the Maracaibo Region, Venezuela.

THE Maracaibo Basin, situated in western Venezuela, is an area of some 25,000 square miles, embracing the State of Zulia and parts of the States of Mérida, Táchira, and Trujillo; within this region occur the principal oilfields of Venezuela, while those of the State of Falcon, lying to the east, are geologically connected therewith. Though the presence of oil in this country was known in the early days of the Spanish occupation, commercial exploration did not commence until 1878, when the Government granted a small lease in the State of Táchira; progress was slow, however, and it was not until 1912 that important developments were undertaken, resulting in the discovery of the now famous Mene Grande oilfield. To-day practically the whole of the basin area is held under exploration or prospecting licences, and besides Mene Grande, the oilfields of La Rosa, Ambrosio, El Mene, La Concepcion, La Paz, Rio Palmar, Rio de Oro, and some potential petroliferous territory in the south, have been discovered.

Geologically the Maracaibo Basin corresponds with a vast geosyncline, the centre of which is occupied by Lake Maracaibo; the peripheral mountain ranges to the west, south, and east are composed of igneous and metamorphic rocks flanked by Tertiary and Cretaceous sediments, of which the Miocene formation is conspicuous for its associated gas and oil seepages. West and south of the lake the structures trend N.E.-S.W., thus conforming to the prevalent Andean trend in this part of the country; east of the lake, especially in the Bolivar district, the E.-W. influence of Caribbean tectonics is shown by the major folds. The chief characteristic of all the structures within the basin is their great linear development, usually coupled with gently dipping rocks. The best-known folds are the Mene Grande-Curaçao anticline (with its curious 'spurs' or 'lobes' running at right angles, and on which the Ambrosio and La Rosa fields are located), the Rio de Oro and La Tarra anticlines south-west of the lake, and the Rio Poco fold running parallel to the Mérida Range in the south.

The most important field is that of La Rosa, situated 27 miles S.E. of Maracaibo city, the scene of a famous gusher in 1922, Barroso No. 2, which flowed a million barrels of oil in nine days; since then 125 wells on this field have accounted for 12,000,000 barrels of oil. The Mene Grande field yielded 18,000,000 barrels up to the end of 1925, the oil being of an asphaltic nature with gravity 0·956; it is piped to and refined at San Lorenzo, thence shipped by lake steamer to Curaçao and elsewhere. The El Mene field has produced 4,400,000 barrels from about 50 wells and is noted for its low gravity oil (0·850) and high petrol and kerosene yields (35 and 38 per cent. respectively). The other fields are smaller, though in most cases important extensions are anticipated. Mr. Campbell M. Hunter, from whose paper read before the Institution of Petroleum Technologists on April 13 the foregoing details are taken, is of the opinion that production for this year in the Maracaibo Basin will substantially exceed 30,000,000 barrels, thus placing Venezuela as the fifth, if not the fourth, largest oil-producing country in the world, a remarkable rise in a little more than seven years.

University and Educational Intelligence.

CAMBRIDGE.—The Civil Commissioner for the Eastern Division has written to the Vice-Chancellor tendering to the University the congratulations and thanks of His Majesty's Government for the very notable part it played in assisting towards maintaining essential services during the recent critical period. About 4000 students were enrolled for national service, more than 2000 were actually called up for work, and enthusiastic appreciation has been generally expressed by those who secured from the undergraduates services "willingly given and unselfishly and efficiently performed."

Notice is given that a professor of mineralogy, in succession to the late Prof. Lewis, will be elected on June 26. Candidates are requested to communicate with the Vice-Chancellor on or before June 19.

The Council has proposed graces for the conferring of the following honorary degrees among others: LL.D. on Sir Samuel Hoare, Mr. Ramsay MacDonald, and Sir Frederick Maurice; and Sc.D. on Sir Josiah Stamp.

Sir Arthur Shipley, Master of Christ's College, is being re-appointed as representative of the University on the Council of the Marine Biological Association.

Applications are invited for the John Lucas Walker studentship in pathology, value 300*l.* a year and tenable under certain conditions for three years. Applications must be sent to reach Prof. H. R. Dean, Pathological Laboratory, Medical School, Cambridge, before June 15.

EDINBURGH.—In recognition of the work done by students of the University at Leith Docks during the recent strike, Mr. Thomas Cowan, a retired shipowner, has sent a cheque for 10,000*l.* for the general purposes of the University. In a letter sent with the cheque

Mr. Cowan, who was chairman of the Emergency Committee of the Leith Dock Commissioners, states that he was greatly impressed with the enthusiasm, initiative, and working capacity of the 270 students who undertook service at the docks and helped to relieve the congestion of traffic there.

Liverpool.—The Senate and Council of the University have resolved to confer the degree of Master of Science, *ex officio*, on Mr. Herbert Clifton Chadwick in consideration of meritorious services rendered to the staff and students, and of distinction in Zoological research during the period 1897-1922, when he was curator of the Marine Biological Station at Port Erin, Isle of Man.

Two post-graduate research fellows will shortly be appointed to the Munitions Committee Research Fellowships, and applications are invited from graduates of the University engaged in industry or research. The value of each fellowship is 250*l.* for the first year and 350*l.* for a second if the appointment be renewed. Applications should reach the Dean of the Faculty of Engineering before June 15.

Prof. A. Stock of Dahlem, Berlin, has been appointed Director of the Chemical Institute at the Technische Hochschule in Carlsruhe.

Prof. Bohuslav Brauner, director of the Chemical Institut of the Charles University of Prague and an Hon. D.Sc of the University of Manchester, has been elected an honorary member of the American Chemical Society.

The degree of Doctor Rerum Naturalium has been conferred in the Charles IV. University of Prague upon Mr. Edward Browning Sanigar, of Sheffield, for his thesis "The Electrolysis of Complex Cyanides with the Dropping Mercury Cathode." This is the fourth doctorate of this University conferred in recent years on an Englishman.

The Carnegie Endowment for International Peace has three divisions: Intercourse and Education, International Law, and Economics and History. A report on the work of the first division has recently been issued by the Director, Dr Nicholas Murray Butler, who is also president of the Endowment. It tells first of the progress of the arrangements for the restoration of the library of the University of Louvain. A sum of 200,000*l.*, towards which the Carnegie Endowment has contributed 31,400*l.*, has been collected, and this will suffice not only for restoration but also for a maintenance endowment of 20,000*l.* Chief among the projects to which funds were allotted during the year is a conference of representatives of the Press of the United States which was to be held with the co-operation of the Academy of Political Science in May in the vicinity of New York. The Division has also invited some fifty American college and normal school teachers of international law and international relations in the United States to visit Paris, The Hague and Geneva during August and September next. At Geneva this party will be in charge of the American Committee of the Geneva Institute of International Relations, to which the Endowment gave 800*l.* last year. The Committee maintains an office for the reception of English-speaking visitors who come to Geneva to study international co-operation. The report announces the constitution of a Comité d'Administration to serve as an executive committee of the Division for work in Europe with offices at the Centre Européen, 173 Boulevard Saint-Germain, Paris. It is about to issue a new quarterly international review, *L'Esprit International*.

Contemporary Birthdays.

June 5, 1843.	Dr. Samuel Garman.
June 6, 1842.	Mr. Henry Martyn Taylor, F.R.S.
June 7, 1877.	Prof. Charles G. Barkla, F.R.S.
June 7, 1868.	Prof. John S. Townsend, F.R.S.
June 9, 1875.	Dr. Henry Hallett Dale, F.R.S.
June 10, 1866.	Lord Montagu of Beaulieu, K.C.I.E
June 11, 1867.	Prof. Charles Fabry.

Dr. Samuel Garman, the veteran naturalist, foreign member of the Linnean Society, was born at Indiana U.S.A. Graduating at Illinois State Normal University, he came for a brief period under the guidance of Louis Agassiz. Dr. Garman has been on the herpetological and ichthyological staff of the Museum of Comparative Zoology, Harvard University, since 1871. He accompanied the late Alexander Agassiz on most of his South American expeditions connected with deep-sea survey work. Dr. Garman is the author of "The Reptiles of Easter Island" (1908).

Mr. H. M. Taylor was born at Bristol and educated at Wakefield Grammar School and Trinity College Cambridge, graduating (1865) third wrangler. In this year the late Lord Rayleigh was the senior wrangler and the late Prof. Alfred Marshall, the economist second wrangler. Being blind himself, Mr. Taylor has long been personally identified with the production of embossed books on scientific subjects. We believe that he once composed a standard algebraical treatise in Braille type, afterwards read the copy with his fingers, and again, later, read the proof.

Prof. Barkla, a Lancashire man, born at Widnes was educated at University College, Liverpool, going from there to Trinity College, Cambridge, where early he came under the inspiring influence of Sir Joseph J. Thomson. He was appointed Wheatstone professor of physics in King's College, London, in 1909 and since 1913 he has occupied the chair of natural philosophy in the University of Edinburgh Prof Barkla's particular investigations have dealt mainly with X-rays and their absorption and secondary emission by solid substances. He was Nobel laureate in physics in 1917, whilst also in that year he was allotted the Royal Society's Hughes medal.

Prof. Townsend, born in Galway, was educated at Trinity College, Dublin, and at Cambridge. He is a chevalier of the Legion of Honour. In 1914 he received the Hughes medal of the Royal Society for his researches on electric induction in gases.

Dr. Dale is a Londoner. He was educated at Tollington Park School, London, and the Leys School Cambridge, graduating afterwards at Trinity College Last year he was elected one of the secretaries of the Royal Society.

Lord Montagu of Beaulieu was educated at Eton and New College, Oxford. Automobilism and aviation are among his interests. He is a verderer of the New Forest.

M. Fabry, professor of physics at the Sorbonne Paris, was born at Marseilles. In 1918, jointly with Dr. A. Perot, the Royal Society allotted them its Rumford medal in respect of their contributions to optics, particularly for the introduction of a new method of measuring wave-lengths by utilising the luminous rings formed by interference between two reflecting plates. Recently Prof. Fabry lectured before the Physical Society of London on the absorption of radiation by the upper atmosphere.

Societies and Academies.

LONDON.

Royal Society, May 20.—A. V. Hill: The laws of muscular motion (Croonian lecture). In all kinds of contractile tissues there are certain similar, or analogous, processes; so that in discussing properties of striated muscle we are really dealing with very general phenomena. Recent work on the chemical reactions of breakdown and recovery, and the rôle of glycogen, lactic acid and phosphate was discussed. If physiological response of muscle undergoing stretch be less than that of muscle allowed to shorten, why is the tension at any given length so much greater during stretch than during shortening? The answer provides an important clue to the nature of the contractile process. Re-development of contraction after quick release was discussed, and also the 'viscous-elastic' model.

Society of Public Analysts, May 18.—A. Chaston **Chapman**: The detection and determination of glycerin in tobacco. The tobacco is mixed with sodium sulphate (to absorb moisture) and extracted with acetone. The residue from the extract is freed from resins, and its glycerol content determined by a modification of Zeisel's silver iodide method. For a qualitative test the glycerin is separated by extraction and distillation.—Harold **Toms**: The crystalline bromides of linseed and some other oils. The most insoluble bromide of linseed oil, as crystallised from ethyl acetate, is not an ethyl ester, but a glyceride. When hydrolysed with hydrobromic acid it yields, as its only recognisable product, hexabromostearic acid, but this does not prove the absence of tetrabromostearic acid, which is converted by hydrobromic acid into a sticky derivative. The insoluble bromides of perilla, candlenut and para rubber seed oils are identical with the linseed oil bromide. Tetralin is a better solvent than ethyl acetate for crystallising oil bromides.—A. **Bakke** and Paula **Henegger**: The polarimetric determination of sucrose in condensed milk. A modification of the method of Revis and Payne is used, employing mercuric nitrate both as precipitant and as inverting agent. Results agreeing with the gravimetric results were obtained in the winter months, but there was a discrepancy in summer due to such causes as altered period of lactation, period of fresh grass feed, etc., on the original milk.—W. R. **Schoeller**: The separation of iridium from iron. The method used is based on the precipitation of ammonium chloroiridate $(NH_4)_2IrCl_6$; allowance is made for the amount of iron adsorbed by the ammonium chloride precipitate.—H. L. **Smith** and J. H. **Cooke**: The determination of very small quantities of iron. A colorimetric method has been devised in which the sensitiveness of the thiocyanate reaction is very greatly increased. Zinc interferes, and for determining iron in zinc compounds the iron thiocyanite is extracted with a suitable solvent, such as a mixture of amyl alcohol and ether, and the colour of the extract matched.—J. N. **Rakshit**: The determination of total alkaloids, sugar, and oily substances in opium. The alkaloids in an aqueous extract of opium and those remaining in admixture with the opium wax are determined. For the determination of sugar, titration with Fehling's solution after removal of alkaloids gives fairly concordant results. Added oil or wax is indicated by a saponification value differing from that of opium wax, and is approximately determined by the appearance of the opium when heated on a plate over steam.

Royal Meteorological Society, May 19.—E. S. **Player**: Meteorological conditions and sound transmission. (i.) Sounds originating on the surface. Observations were made near the North Foreland, Kent, the sources of sound being the sirens of the light-vessels in the locality. Note-frequency of the sirens did not vary, and, the light-vessels being stationary, distances and bearings remained constant. Examples were met of rapid and continual changes over very short periods in sound intensity, and the effects of humidity, temperature, rain, and the general combination of conditions, were examined. (ii.) Sounds arriving from an altitude. The sources used were aeroplane notes which vary in frequency and obviously occupy positions which are continually changing. Observations of upper-air conditions showed a practically constant fall in temperature, but strata of varying relative humidity. Sound was transmitted well when the variations of these strata were small, and the atmosphere, therefore, more nearly approached a homogeneous state; great or abrupt changes had a destructive effect. Acoustical conditions were often good for surface sounds, while bad for sounds transmitted from an altitude, and vice versa.—J. **Glasspoole**: The wet summer of 1924 and other wet seasons in the British Isles. Maps are given of the rainfall (as a percentage of the normal) of this and other wet seasons over the British Isles since 1870, of from three to seven months' duration. Seventeen such periods are recorded. A comparison of the maps with those for dry periods indicates that while large deficiencies are confined mainly to the south and east of the British Isles, large excesses do occur in the north and west.—C. E. P **Brooks**: Pressure distributions associated with wet seasons in the British Isles. The average pressure distribution over the northern hemisphere during each of the wet periods enumerated above from 1876 to 1924, represented as deviations from normal, fall into two clearly defined types. (*a*) Greatest deficit of pressure over Iceland; (*b*) greatest deficit of pressure over the British Isles. With a pressure distribution of type (*a*) the S.W. winds over the British Isles would be stronger than normal, giving more orographic rain on the western highlands, and in the four periods classed as of this type, the rainfall distribution was found to be mainly orographic. With a pressure distribution of type (*b*) there would be a tendency for depressions to pass directly across the British Islands, giving an excess of rainfall over the whole country (cyclonic type), and with the exception of April-June 1907, all the periods with a pressure distribution of type (*b*) had this type of rainfall distribution. The conditions in the Atlantic Ocean during and preceding these wet periods were then investigated. (1) Favourable to a wet period of the mainly orographic type: N.E. trade wind velocity below normal nine to twelve months before; S.E. trade wind velocity below normal twelve months before; pressure difference, Sydney (Nova Scotia) minus Ivigtut (Greenland) above normal three months before; amount of ice near Iceland below normal during the wet period. (2) Favourable to a wet period of the mainly cyclonic type: Pressure difference, Sydney minus Ivigtut, above normal three months before; amount of ice near Iceland above normal in preceding spring, but below normal during the wet period. The weak N.E. and S.E. trades and the large pressure difference between Sydney and Ivigtut all contribute to a lower temperature in the North Atlantic, which may thus be the chief cause of a wet season in the British Isles. The part played by the Iceland ice is probably to determine the location of the greatest deficit of pressure.

MANCHESTER.

Literary and Philosophical Society, May 11.—John **Walton**: (1) On some Australian fossil plants referrable to the genus Leptophlœum, Dawson. The paper deals with the genus Leptophlœum, Dawson, instituted in 1862 for a fossil stem of Lycopod affinities from the Upper Devonian of Maine, U.S.A. The importance of some of the features exhibited by the type specimen was stressed, particularly in connexion with the relation between this fossil and the Australian fossils which have been referred to *Lepidodendron australe* or *Leptophlœum australe*. Some hitherto undescribed features of the Australian plants were described. (2) A note on the structure of the plant-cuticles in the paper coal from Toula in Central Russia. These cuticles have been referred to Bothrodendron by some authors, and to Lepidodendron by others. In some specimens the presence of the cuticle of the ligular pit can be demonstrated. The evidence for referring these fossils either to one or the other of the two genera is of a conflicting nature, but on the whole it seems in favour of Bothrodendron. There is considerable difficulty in distinguishing between the smaller vegetative branches of Lepidodendron and Bothrodendron.

PARIS.

Academy of Sciences, April 26.—Maurice **Hamy**: A particular case of the diffraction of solar images.—André **Blondel**: The modulation of transmitting stations with valves fed with continuous current.—S. **Winogradsky**: Spontaneous cultures of (nitrogen) fixing micro-organisms. A study of the substances favourable to the growth of Azobacter in earth cultures.—Charles **Nicolle**, E. **Conseil** and P. **Durand**: The agent of scarlet fever. The authors' experiments confirm the views of Dick, that scarlet fever is due to a Streptococcus, and can be prevented by a vaccine.—Axel **Egnell**: Curvature and divergence.—A. **Demoulin**: Conformal geometry of surfaces and of triple orthogonal systems.—F. P. **Bessonoff**: Nearly periodic functions with one complex variable, defined in the whole of a plane.—Paul **Le Rolland**: The measurement of hardness by the pendulum. A claim for priority in the use of the pendulum for measuring hardness of metals.—Eugène **Barré**: The theory of mine craters.—T. V. **Jonescu**: The variations of intensity of the thermionic current when the distance between the filament and the anode is changed.—Léon and Eugène **Bloch**: A second spark spectrum of iron. A comparison of the arc and spark spectra of iron between the wave-lengths 2300 and 1850 Å.U. shows that the arc spectrum and condensed spark spectrum are clearly different, and to such an extent that it is difficult to find in one the lines characteristic of the other.—E. **Dureuil**: The use of magnesium as electrode supports in spectrum analysis. Magnesium as a support in spectrum analysis has certain advantages over the materials commonly used. In the region between 7000 Å.U. and 3500 Å.U. there are only about a dozen strong lines and these do not interfere. Magnesium electrodes can be used for the production of either arc or spark spectra.—René **Lucas**: The rotatory power of camphor. Experiments giving the rotatory power of camphor for different wave-lengths in sulphuric and phosphoric acid solutions, and a discussion of some criticisms of Louis Longchambon.—G. **Bruhat** and M. **Pauthenier**: The rotatory power in the ultra-violet of tartaric acid in dilute solution. Details of experiments are given which show clearly the existence of a dispersion anomaly, with a change of sign in the ultra-violet, even for solutions containing 0·25 per cent. of tartaric acid.—Pierre **Jolibois**, Henri **Lefebvre** and Pierre **Montagne**: The decomposition of carbon dioxide under reduced pressure by the condensed spark. When the circuit is formed with a conductor of negligible self-induction, removed as far as possible from the decomposition tube except in the neighbourhood of the connexions, the dissociation reaches a limiting value of about 90 per cent. and the yield in chemical energy of the first spark is of the order of 20 per cent., the remainder of the energy of the spark being degraded in the form of radiation.—Mlle. Suzanne **Veil**: The decomposition of hydrogen peroxide in the presence of certain hydroxides in suspension. During the decomposition of hydrogen peroxide by the hydroxides of nickel, iron and chromium in suspension, the chemical phenomena correspond with a magnetic variation of the solid phase. The term 'magneto-chemical' is suggested for such reactions.—L. **Abonnenc**: Drops formed in an electric field. Drops forming at the end of a cylindrical tube are generally reduced in weight when placed in an electric field. It is shown that the viscosity of the fluid remains unchanged.—A. **Demay**: The structure of the crystalline massif of Mont Pilat, near Saint-Etienne.—P. **Russo**: The presence of quaternary glacial deposits in the eastern Riff.—P. **Mougin**: The periodicity of glacier increase.—J. **Thoulet**: The region of active submarine volcanoes of the Hawaii Islands in the north Pacific.— —**Theodor**: The formation of the chromoplasts in the Phanerogams.—Mlle. Eudoxie **Bachrach**: The effects of the intoxication of the lactic bacillus by potassium chloride at different temperatures. Under the prolonged influence of a mineral poison it is known that the lactic bacillus undergoes one of two modifications: either it becomes accustomed to the poison or becomes sensitised. It is now shown that according to the temperature at which the strains are cultivated in the toxic medium, either modification can be obtained at will.—A. **Paillot** and R. **Noel**: The origin of the albumenoid inclusions of the adipose body of insects.—**Raymond-Hamet**: A new method of physiological titration of preparations of ergot.—J. **Gautrelet**, R. **Bargy** and Mme. **Vechiu**: The action of chloralose on the nervous system.—Maurice **Piettre**: The acetone method permitting the localisation in the serum albumen of the hæmolysine of a hæmolytic immunoserum.—J. **Sabrazes**: The Spirochætes of typhoid and paratyphoid excreta; their possible agglutinability by the blood of the carrier; their presence in peritonitis by perforation.—Georges **Blanc** and Jean **Caminopetros**: Some experiments on anthrax infection. Experiments are described showing that the skin is not the only part sensible to anthrax infection, the central nervous system being much more receptive.—**Marage**: The influence of the dose of a drug on the defence of the organism

ROME.

Royal Academy of the Lincei, March 21.—Umberto **Cisotti**: The electrostatic field due to any number of thin electrified conductors of cylindrical form and with parallel axes.—Giovanni **Lampariello**: Continuous surfaces which assume finite area.—Orazio **Lazzarino**: Generalisation of Joukovsky's formula on the motion by inertia of a semi-rigid gyroscope.—Guérard des **Lauriers**: Dini's problem.—A **Kolmogoroff** and G. **Seliverstoff**: The convergence of Fourier's series.—Bianca **Nannei**: Immediate effects and hereditary effects in the torsion of a bismuth wire.—Paolo **Straneo**: Physical bases for an extension of the theory of hereditary phenomena.—A. **Proviero**: The use of damping in seismographs. The use of damping in seismographs is unnecessary and, although a damped apparatus gives trustworthy values of the term μ^2, it is almost replaceable by a single non-damped apparatus and is certainly of less advantage than two non-synchronous seismographs.—Adolfo **Ferrari**: The crystalline structure of the fluorides of certain divalent metals. The anhydrous fluorides, FeF_2, CoF_2, NiF_2, and ZnF_2, exhibit the same tetragonal crystalline lattice, which is of the 'rutile' type.—V. **Caglioti**: A new example of anomalous mixed crystals.—P. **Comucci**: Notes on wulfeenit and vanadinite from Oudida (Morocco).—Cramela **Ruiz**: Barytes from the Giona mine (Racalmuto).—Enoch **Peserico**: Variation in the electrical resistance of the submaxillary gland during functional activity.—C. **Iucci**: Capacity for parthogenesis of the egg of the second generation of the bivoltine race of silkworms.

SYDNEY.

Linnean Society of New South Wales, March 31.—H. J. **Carter**: Entomology—past and present (presidential address). The scientific conception of entomology is modern. The seven orders into which Linnæus divided insects are, with one exception, surprisingly near the modern classification. Historical entomological records show the close interweaving of observation with pure fable characteristic of natural history literature, and great dependence on 'authority' and on superficial evidence. The great importance of the study of entomology and its increasing penetration into practical politics is also discussed. The immense number of insects, their complexity of form and development, their close interrelation, and their vast geological age give them a peculiar value to students of evolution and genetics. Australia, in particular, with its huge area of lightly differentiated regions—so far as defined zoogeographic barriers are concerned—affords a good field for the study of variation. The economic aspect of entomology is becoming more important. Reference is made to the attempts to control such pests in North America as the gipsy moth, the European corn borer, and the Japanese beetle, and in Australia the prickly pear, the cattle tick, and the sheep blow-fly. Satisfaction is expressed at the increasing number of Australian entomologists entering various fields. Among the advantages of having the systematic work done by Australians are: (1) The work is done largely by men who combine field observation with literary knowledge of the subject, and (2) the types remain in Australia for reference.—J. R. **Malloch**: Notes on Australian Diptera (No. viii.). Descriptions and notes on further Australian and Tasmanian species of Sapromyzidæ, Clusioididæ and Muscidæ; one genus and twenty-eight species are described as new.—R. J. **Tillyard**: Upper Permian insects of New South Wales. Part I. Introduction and the order Hemiptera. The upper Permian insect fauna found at Belmont, Warner's Bay, Merewether Beach, and Newcastle, N.S.W., is by far the most highly specialised Palæozoic insect fauna known, and consists of only small to medium-sized species belonging to the orders Hemiptera, Coleoptera, Mecoptera and Neuroptera, together with the two extinct orders, Paramecoptera and Protocoleoptera. All these were holometabolous or ancestral to holometabolous forms, except only the Hemiptera, which are only represented by the sub-order Homoptera. In the Homoptera five families (all now extinct) are represented, with fifteen genera and twenty-eight species, twenty-four of which are described as new. The fauna thus ranks next in importance in number of genera and species to that of the Ipswich Upper Triassic in Queensland; as regards the Sternorrhyncha, it is the richest fauna yet discovered.—C. H. **Curran** and E. H. **Bryan**, Jr.: The Australian Syrphidæ in the Bishop Museum (Diptera). The apparent abundance of species of Psilota is noteworthy as this genus is poorly represented in other parts of the world. Five species (two of Psilota, one Chrysogaster, one Microdon, and one Cerioides) are described as new.—G. H. **Cunningham**: Gasteromycetes of Australasia (iv.). Species of the genus Geaster.

WASHINGTON.

National Academy of Sciences (Proc. vol. 12, No. 4, April).—Carl **Barus**: Mutually counteracting pinhole probes.—Frank C. **Hoyt**: Transition probabilities and principal quantum numbers. Using the 'classical' form of the quantum theory, the transition probabilities are calculated from the term values of the stationary states of an atom alone, and the corresponding amplitudes can also be found. No justification is offered for the method of averaging used.—W. H. **McCurdy**: Absorption and resonance radiation in excited helium and the structure of the 3889 line. See NATURE, January 23, p. 122. The line 3889 Å.U. has a weak component 0·044 Å.U. to the short wave-length side of the main component.—B. **Bruzs**: Thermodynamic derivation of a black body radiation isotherm. A number of processes of the form $A \rightarrow B - Q$, where Q is connected with the absorption of heat, are considered. An 'ideal' substance is used and Q is assumed to be independent of temperature.—Enos E. **Witmer**: Critical potentials and the heat of dissociation of hydrogen as determined from its ultra-violet band spectrum. Lyman found that in the presence of a large proportion of argon, helium emits groups of lines between λλ 1063 and 1670. Working on these results, the heat of dissociation of the hydrogen molecule is considered to be equal to the vibrational energy for that value of the vibrational quantum number at which the frequency is zero. The probable value is 4·34 volts or 100,100 calories. The higher resonance potentials and the ionisation potentials of the hydrogen molecule are calculated.—G. Y. **Rainich**: Curved space-time and radiation. The suggestion is put forward that radiation is concentrated in singular lines, when intensity becomes a statistical conception similar to that of modern conceptions of the mass of a body. This points to a reconciliation of the wave theory of light with the emission theory.—Friedrich G. **Brieger** and A. J. **Mangelsdorf**: Linkage between a flower colour factor and self-sterility factors. Three allelomorphic sterility factors are recognised in Nicotiana. The factor for ivory flower colour and the sterility factors segregate independently; white flower colour is linked with them.—Clyde E. **Keeler**: On the occurrence in the house mouse of a Mendelising structural defect of the retina producing blindness. The defect is characterised by complete absence of rods and external molecular layer and reduction of the external nuclear layer, resulting in total blindness. It affects both sexes, behaves as a Mendelian recessive, carries no lethal action, and appears after birth.—Raymond **Pearl**: Vital statistics of the National Academy of Sciences. (5) The growth of the Academy. The numbers of living members on December 31 of each year are used. In the years 1863–76 the Academy doubled its membership; from 1867–90 it maintained a membership of about a hundred, decreasing afterwards until 1898. Since then it has steadily grown, and at the end of 1925 had reached 230.—Einar **Hille**: On Laguerre's series. (1) The formal Laguerre's series of a certain class of functions can be shown to be summable Abel. Expansions of zero are obtained and a summation theorem for Hermitian series is given. (2) The summation theorem of (1) can be utilised in the convergence theory of Laguerre's series.—G. A. Miller: Groups containing a relatively small number of Sylow subgroups.

Official Publications Received.

Rhodesia Museum, Bulawayo. Twenty-fourth Annual Report, 1925. Pp. 15. (Bulawayo.)

Report of the Canadian Arctic Expedition, 1913-18. Vol. 14: Eskimo Songs. Songs of the Copper Eskimos. By Helen H. Roberts and D. Jenness. Southern Party, 1913-16. Pp. 506. (Ottawa: F. A. Acland.)

New Zealand. Department of Mines: Geological Survey Branch. Bulletin No. 27 (New Series): The Geology of the Whangarei-Bay of Islands Subdivision, Kaipara Division. By H. T. Ferrar and others. Pp. viii+134+6 plates. (Wellington, N.Z.: W. A. G. Skinner.) 15s.

National Research Endowment. A National Fund for the Support of Research in Pure Science. Pp. 23. (Washington, D.C.: National Academy of Sciences.)

Public Library, Museum and Art Gallery of South Australia. Records of the South Australian Museum. Vol. 3, No. 2. Pp. 103-217. (Adelaide.) 10s. 6d.

Department of Public Instruction: Technical Education Branch, New South Wales. Technological Museum: Annual Report for Year ended 31st December 1925. Pp. 4. (Sydney, N.S.W.: Alfred James Kent.)

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 14: Theory of Airscrews. By Sandi Kawada. Pp. 361-404. (Tôkyô: Maruzen Kabushiki-Kaisha.) 75 sen.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Dominica, 1924-25. Pp. iv+34. (Barbados, B.W.I.) 6d.

The Indian Forest Records. (Economy Series), Vol. 12, Part 3: Second Interim Report on the Work under Project No. 1 by the Section of Timber Testing including the Results of the Mechanical and Physical Tests on certain of the commoner Indian Timbers up to end of 1924. By L. N. Seaman, assisted by C. R. Ranganathan. Pp. 22+10 plates. (Calcutta: Government of India Central Publication Branch.) 1.12 rupees; 2s.

State of Illinois Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol. 15, Article 8: An Entomological Survey of the Salt Fork of the Vermilion River in 1921, with a Bibliography of Aquatic Insects. By Charles P. Alexander. Pp. 439-536. Bulletin, Vol. 15, Article 9: The Lake as a Microcosm. By Stephen A. Forbes. Pp. 537-550. (Urbana, Ill.)

Memoirs of the Queensland Museum. Edited by Heber A. Longman. Vol. 8, Part 3, March 31. Pp. 183-278+plates 29-42. (Brisbane, Qd.)

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 42: Statistics of State School Systems, 1923-1924. Pp. 48. (Washington, D.C.: Government Printing Office.) 10 cents.

Diary of Societies.

SATURDAY, June 5.

Royal Society of Medicine (Otology Section), at 10.30 A.M.—Dr. W. H. Hartridge: The Fundamental Experiments on which the Resonance Theory is based.

North of England Institute of Mining and Mechanical Engineers (Associates' and Students' Section) (at Newcastle-on-Tyne), at 3.—P. S. Lea: Notes on Safety Lamps abstracted from Recent Reports.

Royal Institution of Great Britain, at 3.—Sir Walford Davies: The Triad and the Perfect Fourth; their Uses from Hucbald to the Present Day. (With Musical Illustrations.)

MONDAY, June 7.

Royal Society of Edinburgh, at 4.30.—Prof. F. H. Edgeworth: On the Development of the Cranial Muscles in Protopterus and Lepidosiren.—Dr. G. W. Tyrrell and Dr. M. A. Peacock: The Petrology of Iceland. Part 1—The Basic Tuffs.—MM. Prawochenski and Kaczkowski: Observations on the Fragment of a Horse Skull from Interglacial Deposits near Pulawy, Poland.—Y. Tamura and Dr. F. A. E. Crew: On the Effects of Vasectomy and of Epididymo-Deferentectomy in the Mouse.

Institute of Actuaries, at 5.

Royal Institution of Great Britain, at 5.—General Meeting.

Aristotelian Society (at University of London Club), at 8.—Dr. C. Delisle Burns: The Activity of Mind.

Royal Society of Medicine (Social Evening), at 9.30.—F. T. G. Hobday: Our Animal Friends as Patients (Address).

TUESDAY, June 8.

Royal Anthropological Institute (Exhibition of Tardenoisian and Pigmy Types of Stone Implements), at 2.30 (continued until June 22).

Manchester Geological and Mining Society, at 4.

Royal Institution of Great Britain, at 5.15.—Brig.-Gen. Sir Percy Sykes: Chinese Turkestan and the Pamirs.

Quekett Microscopical Club, at 7.30.—E. Heron-Allen and A. Earland: Selective Building in the Shells of the Foraminifera.

Röntgen Society (Annual General Meeting) (at British Institute of Radiology), at 8.15.—A. E. Speight: Abstracts from Apparatus and Technique for Radiography of the Accessory Sinuses.—Dr. L. A. Levy and D. W. West: A New Method of Dosage for Use in Actinotherapy.

Royal Anthropological Institute (at London School of Economics), at 8.30.—M. Terry: Some Little Studied Aborigines encountered during Travels in Northern Australia.

WEDNESDAY, June 9.

Royal Institution of Great Britain, at 5.15.—Prof. J. Barcroft: Organs of Multiple Function (4). Lungs.

Geological Society of London, at 5.30.—Dr. W. D. Lang: *Nas pagoda* (Salter): the Type of a New Genus of Silurian Corals.—J. F. Jackson: The Junction-Bed of the Middle and Upper Lias on the Dorset Coast.—Prof. P. G. H. Boswell: A Contribution to the Geology of the Eastern Part of the Denbighshire Moors.

Radio Society of Great Britain (Informal Meeting) (at Institution of Electrical Engineers), at 6.

Institute of Water Engineers (at Manchester) (continued on June 10, 11, and 12).

THURSDAY, June 10

Royal Society, at 4.30.—Dr. A. V. Hill: The Viscous-Elastic Properties of Smooth Muscle.—A. S. Parkes: (a) Observations on the Œstrous Cycle of the Albino Mouse; (b) On the Occurrence of the Œstrous Cycle after X-Ray Sterilisation.—Isabella Gordon: The Development of the Calcareous Test of *Echinocardium cordatum*.—J. Walton: Contributions to the Knowledge of Lower Carboniferous Plants.—Prof. J. H. Priestley and E. Rhodes: On the Macro-Chemistry of the Endodermis.—D. Keilin: A Comparative Study of Turacin and Hæmatin and its Bearing on Cytochrome.—E. Ponder: The Equations applicable to simple Hæmolytic Reactions.—J. P. Hoet and Phyllis Kerridge: Observations on the Muscles of Normal and Moulting Crustacea.—C. H. Best and H. P. Marks: Additional Note on the Effect of Insulin on the Lactacidogen Content of the Skeletal Muscles.

Institute of Pathology and Research (St. Mary's Hospital, Paddington), at 5.—Dr. J. Freeman: The Pathological Mechanism of the Asthma Syndrome.

Linnean Society of London, at 5.

London Mathematical Society (at Royal Astronomical Society), at 5.—

Royal Institution of Great Britain, at 5.15.—Dr. J. Newton Friend: Science in Antiquity (2).

Optical Society (at Imperial College of Science and Technology), at 7.30.—Dr. L. C. Martin: The Distribution of Light in Elementary Optical Images.—T. Smith: (a) Note on the Criterion for the Best Position of Focus; (b) The Stationary Position of Axially Symmetric Functions.

FRIDAY, June 11.

Royal Society of Arts (Indian Meeting), at 4.30.—Capt. B. K. Featherstone: Exploration in the Karakoram Mountains.

Royal Astronomical Society, at 5.—A. N. Brown: Observations of V Cassiopeiæ (Ch. 8534) in 1921-26.—Dr. J. H. Jeans: Stellar Opacity and the Atomic Weight of Stellar Matter.—Dr. W. J. S. Lockyer: The Spectrum of the Bright-Hydrogen-Line Star H.D.C. 20336 in Camelopardalis (Sp. Type B3 pe).—L. J. Comrie: The Standard Equinox of 1950.0.

Physical Society of London (at Imperial College of Science and Technology), at 5.—J. H. Awbery and Dr. Ezer Griffiths: The Latent Heat of Fusion of some Metals.—D. W. Dye: The Piezo-electric Quartz Resonator and its Equivalent Electric Circuit.—E. J. Evans: The Characteristics of Electrostatic Machines on Non-inductive Loads and on the Coolidge Tube.

Malacological Society of London (at Linnean Society), at 6.

Royal Society of Medicine (Ophthalmology Section) (Annual General Meeting), at 8.30.—R. Pickard: The Visual Field in Atheroma of the Retinal Vessels.

Royal Institution of Great Britain, at 9.—Prof. J. C. McLennan: The Spectrum of the Aurora.

CONGRESS.

June 9 to 12.

South-Eastern Union of Scientific Societies (at Colchester).

June 9.—R. A. Smith: Essex in Pre-Saxon Times (Presidential Address).

June 10.—R. Paulson: The Beechwood; its Canopy and Carpet; Dr. E. J. Salisbury: The Plant Communities of the Seashore; C. E. Benham: Dr. Wm. Gilberd of Colchester, author of "De Magnete"; Alderman W. G. Benham: The Borough Arms at Colchester.

June 11.—E. C. Stuart Baker: Some Curious Aspects of Evolution; Alderman W. G. Benham: The Colchester Oyster Fishery; S. Hazzledine Warren: The Correlation of the Lower Palæolithic; E. A. Martin: Break-Names in Geological History.

June 12.—A. Farquharson: The Social Constitution of a County; G. E. Hutchings: The Choice of Maps for Regional Surveys; Dr. C. Tierney: Some of Nature's Secrets.

CONVENTION.

June 7 to 12.

Photographic Convention of the United Kingdom (at Edinburgh).

PUBLIC LECTURES.

MONDAY, June 7.

Royal College of Science, at 5.30.—H. E. Wimperis: The Relationship of Physics to Aeronautical Research. (Institute of Physics Lectures on "Physics in Industry.")

WEDNESDAY, June 9.

King's College, at 5.30.—Prof. S. Radhakrishnan: The Philosophic Basis of Hinduism. (Succeeding Lectures, under auspices of British Institute of Philosophical Studies, on June 16 and 23.)

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Technical and Intellectual Values.

VERY frequently we hear the complaint that, in connexion with certain of our activities, there are too many conferences and too little achievement. Specialists gather to discuss their own aspirations and grievances; they deliver their criticisms and indicate how society is refusing the positive reconstruction which would result from the realisation of the aspirations, the removal of the grievances, and the careful examination of the criticisms: but definite suggestions which shall be understood by the plain man are said to be rare. The complaint may be justified particularly where the specialists are concerned with teaching and with the implications of scientific developments. In both cases, results, so far as they affect the life of the plain man, are not immediately apparent, and he is therefore apt to glance at conference reports with some impatience and hasten back to his more 'practical' pursuits.

It is to be expected, therefore, that he will pass over certain resolutions passed by the Conference of Teachers in Technical Institutions which was held in London on May 22–25. He may not be alarmed by the statement that, just as the results of the Board of Education's Circular 1371 and Memo. 44 would have been a reduction of the standard of educational efficiency, so will be the result of the introduction of the same underlying principles in the Economy Act. He will not be moved by the opinion of the Conference that courses in junior technical schools should be as wide as, though differing in character from, those in secondary schools, since his general acquiescence to "secondary education for all" is usually accompanied by a happy ignorance of the multitudinous definitions and of the varying branches of education to which so many labels are being attached. It is certainly very doubtful whether he would be very enthusiastic concerning the Conference's declaration in favour of the principle of internal examinations in all grouped courses, or share the Conference's alarm at the increasing number of external examinations which are being organised by various unions of education authorities—an alarm great enough to spur the Conference to call for a representative meeting of local education authorities and teachers in technical institutions in order to consider the best method of obtaining a system of examinations for those groups of subjects in which National Certificates are not in being or in process of formation.

Arising out of the Conference (if not, in each case, specifically indicated on its public programme), however, were three matters which will commend themselves both to the plain man and the specialists concerned

The new president of the Association, Mr. A. E. Evans, of the Battersea Polytechnic, delivered an address which has already received considerable comment in the general press. "It is high time," he said, "that we abolished the intellectual snobbery and make-believe that regards Art, Literature, Music and the Classics as members of an aristocratic family with Science as a sort of distant cousin, whilst Technology and Commerce are spurned as illegitimates." Whether or not the image be overdrawn matters very little if its presentation will do something towards speeding up the great family reconciliation which, doubtless as a result of the efforts of Mr. Evans's Association and its allied bodies, is slowly taking place. Mr. Evans's purpose was to remind those who pay the ideas much lip-service (but do little towards their practical realisation) that one might as well try to separate the two poles of a magnet as try to divide education into two parts—cultural and vocational; that the good citizen is not one who avoids breaking laws, but one who deliberately *does* something for his day and generation; that engineering, chemistry, commerce, and the like have as great a humanitarian value if taught in the right way as any of those branches of learning beloved by the pedants, since subjects taught on the 'vocational' side of technical institutions teem with examples of how service to humanity has been rendered by their help.

The second important matter was raised by the Mayor of Marylebone, who accorded the Association a civic welcome. On entering public life, he said, men who have been used to one aspect of industry or commerce are faced with entirely new conditions. They have to deal with all sorts of matters from education to electricity proposals and the removal of refuse. They have not merely, as in their business, to be convinced themselves as to the value and necessity of administrative measures, but also to accumulate sufficient knowledge and persuasion to convince their colleagues. The growth and ramifications of public administration are continually increasing. A technical education vitally linked to immediate human needs is therefore imperative for public men. There are large fields of research and study connected with public administration which should be explored by *young* men who will later have the destiny of their fellows in their hands.

The Mayor's point is one of great interest, especially if one reflect on the position occupied by a Medical Officer of Health who, supported by a definite science, presents proposals to his committees, and that of the Director of Education, who has also to formulate proposals for his committees. Both contribute to public welfare, but the Director, lacking a recognised science, sometimes occupies an unenviable position when he is faced by contrary 'opinions' gathered frequently without close examination and research.

The final matter discussed at the Conference may ultimately be proved to be one of the most important of its activities. It was foreshadowed in a speech at the Association's annual dinner. There can be no doubt that some voluntary (and other) educational bodies have tended to regard technical education as concerned almost wholly with the quick preparation of shorthand-writers, plumbers, etc., and it is not to be wondered at that the plain and earnest man may distrust that which he thinks does little more than flood the labour market at public expense. On the other hand, the Association denies this and insists not only on the vital need of its work, but also on its humanitarian value. The position should be made clear not only to teachers but also to the plain man. Technical education has a philosophy which, it is claimed, will commend itself to all. Has it yet been written and published in clear terms? It is not a matter which can be left entirely to university professors of education. Will the Association of Teachers in Technical Institutions supply the deficiency? If it will do so, the reconciliation of the educational family to which Mr. Evans referred will be greatly hastened, and the family itself will discover friends of which, hitherto, it has been quite unaware.

The Centenary of the Athenæum.

History of the Athenæum, 1824–1925. By Humphry Ward. Pp. xii + 370 + 32 plates. (London: Printed for the Club, 1926.)

NO other Club vies with the Athenæum in its interest to scientific men. Faraday was its first secretary, Humphry Davy and Thomas Young were on its first committee; Darwin and Huxley have their portraits on its walls. To four generations of men of science it has been almost a matter of course to belong to it; the young and ambitious have peeped in at its door, and the old have found consolation in looking out of the window. Moreover, scientific men neither monopolise it nor even predominate in it; they share the Club, vastly to their own advantage, with men of letters and affairs, with statesmen, bishops, judges, artists, scholars; with most of those who, for better or for worse, represent the learning of our time and country.

The Athenæum has reached and passed its hundredth birthday, and an old and distinguished member has written the history of its hundred years. A hundred years seems a great while ago, especially to the young but looked at properly, as the old regard it, it is not much after all. When we add to the years which we ourselves remember those penumbral (or half-shadowy) years of which our fathers and grandfathers have told us, we seem to carry our recollections easily back across a hundred years, and perhaps a trifle more. Waterloo seems ever so much the nearer because of the beribboned coach which brought the news to my grandfather's village; I seem to have known Sir Astley Cooper and Mr. Brande pretty well, even the great Sir Humphry in the days when he let Mr. Faraday lecture for him now and then. It is not difficult to keep in touch with a short century ago.

Some time before these hundred years began a great house stood at the foot of Regent Street; the First Gentleman in Europe lived in it, and Nash's great white street (which has lately dissolved away before our eyes, after we had found out its beauty) stretched from the Great Personage's doorstep to the Park on which he had graciously bestowed his name. The critics of the day found fault with Prince and street and everything; "we had hoped," says one, "that that tissue of cast iron and whitewash which reaches from Pall Mall to Portland Place would, at one end at least, have had a redeeming spot to balance the absurdity standing at the other." The house was so big that when they pulled it down the United Service Club was built on one wing of it and ours upon the other, and its doorstep stretched far across the space between. The billiard-room of the Athenæum is said to stand where the Prince Regent had his dining-room; where Herbert Spencer played his game was possibly, nay more was probably, the dreadful spot where the bell had once been rung for Mr. Brummel's carriage.

The Great War (as our grandfathers called it) had left a deal of money in England, and it was spent reely; travel had enlarged men's ideas, and the First Gentleman set no example of economy. He had ecently become a greater personage than ever, and Carlton House was no longer big enough for him; but when he moved into Buckingham Palace his old house was too big for anybody else, and they pulled it down with as little concern as they had shown to the foul lleys round St. James's Market. What had contented nd delighted the eighteenth century did not satisfy the nineteenth; taverns and coffee-houses were good enough for Dryden and for Addison, and Dr. Johnson ound nothing so productive of happiness among all he contrivances of men; but the Waterloo generation outgrew the Mitre and the King's Head. The Guards had their Club after Waterloo; after the Peace, Castlereagh founded the Travellers', for visitors from abroad and for noblemen and gentlemen who had made the Grand Tour, travelling not less than five hundred miles from London; the Oriental (Jos Sedley's Club and Jan Bahawder's) followed soon afterwards. In short, a movement had begun which soon turned the sweet shady side of Pall Mall into a street of palaces, and utterly transformed the social life of London. About the same time a hospitable person called Crockford entertained very handsomely in St. James's, and built a big house at the top of the street at the very time the Athenæum was a-building. White's and Boodle's and Arthur's belonged to a much older lot; they had grown out of the chocolate houses where country gentlemen and men of fashion met, and made it worth the landlord's while to keep out the common people. But apart from these, Clubland as we know it to-day came into being a hundred years ago, as near as may be—in a time of great expansion and prosperity.

The idea is said to have first started in John Murray's house in Albemarle Street (see how near we keep to the present day!) that "literary men and artists required a place of rendezvous," now that the old coffee-houses were superseded and many of them destroyed; and a remarkable man was the first to make the suggestion. John Wilson Croker was the Mr. Pepys of his time; he was Secretary to the Admiralty, like Pepys, he was a fellow of the Royal Society, like Pepys again; he knew everything and everybody; his correspondence was immense, and his diary has helped to keep him famous. Macaulay detested him; Disraeli and Thackeray drew him in ugly colours and unpleasant company. But Disraeli, who was elected to the Athenæum in 1866, might have got in thirty years before had the omnipotent 'Rigby' shown him a helping hand; and the other two had grievances of their own. After all, if Croker did not find in young Disraeli the sort of man he wanted for his club, one need scarcely wonder; it is easier to admire the old Dizzy than the young. Croker had his faults as he had his enemies; but we now think of him as a shrewd, an honourable and a sociable man.

Croker was a bosom friend of Sir Humphry Davy's, who was president of the Royal Society at the time; and in letters to Davy he discussed the character and the constitution of his proposed Club in great detail:

> "In order to keep our Club what it is intended to be, a club of literary men and artists, we must lay down clearly and positively, as our first rule, that no one shall be eligible into it except Gentlemen who have either published some literary or professional work, or a paper in the Philosophical Transactions—Members of the Royal Academy—Trustees (not officials) of the British Museum—Hereditary and Life Governors of the British Institution. The latter will open our doors to the Patrons of the Arts; I do not see any other classes which could be admitted, unless Bishops and Judges, who are *par état* literary men although they have not published any literary work."

There are subtle points in this letter; there is a liberal spirit not entirely emancipated from the social prejudice of the times. I like the notion of "literary men *par état*"—who have written nothing.

The first list of "persons of acknowledged eminence" was filled up easily and handsomely. Sir Walter Scott and Tom Moore, Campbell and Samuel Rogers, represented the literary men of the day. Sir Thomas Lawrence and Chantrey stood for art, together with Robert Smirke the younger, architect of the British Museum and the College of Physicians, a man remembered with respect and praise when he is remembered at all. In science there were the great names of Davy and Thomas Young, to which Faraday's was presently to be added in the humbler rôle of secretary. Among the noble patrons of the arts were Lord Palmerston and Lord Aberdeen, the Lord Lansdowne who filled Bowood with its greatest treasures, Lord Ashburnham the picture-collector, and Lord Spenser of the Althorp Library. There were so many other notable names on the original committee that one may begin by admiring the skill with which Croker and Davy chose their men, and end by wondering at the numerous crowd of distinguished personalities in George IV.'s London.

There was Sir Henry Halford, the Court Physician, a great figure in society; Richard Heber, greatest of bookhunters, who needed three copies of every book, and left eight houses full; Sir George Beaumont, an old man, a friend of Sir Joshua's and a benefactor of Wordsworth—a true patron of the arts; Davies Giddy or Gilbert, the Cornishman, another elderly man, who had discovered young Humphry Davy and (together with his friend Dr. Beddoes) had helped to start him on his illustrious career. There was Thomas Linton Parker, a county magnate in Lancashire, intimate friend of Gainsborough's and learned antiquary; also another scholarly squire, Aylmer Lambert of Boyton in Wiltshire, whose treasures of art were famous in his day and who wrote and published a "Description of the genus *Pinus*," a beautiful and costly book; Henry Thomas Colebrooke, the first Englishman to study Sanskrit; William Stewart Rose, a friend of Sir Walter's and translator of Ariosto; Edward Locker, father of Frederick Locker-Lampson, Secretary to Greenwich Hospital and founder of the gallery of naval portraits in the Painted Hall,—these and two or three more completed the committee. The list is a remarkable one; there is a fine, friendly, gentlemanly air about it; it gives us a glimpse of conditions different from our own, under which the men of professional eminence were fewer, the dilettanti much more numerous and distinguished, and whole classes of men, important and influential to-day, are conspicuous by their absence.

The Club opened its doors in February 1824, in the house in Waterloo Palce now occupied by the Italian State Railways. Croker saw to everything; he engaged the servants, seven men, five women, and three boys, at a total wage of 550*l*. a year; he ordered the coals, he bought the liveries (at 4*l*. 15*s*. per suit, or 10*s*. additional if the committee should prefer plush to velveteen), and the beds and bedsteads, "those for the three upper servants of rather a better kind." He purchased some 500 ounces of beautiful table-silver (still as good as ever) at 7*s*. 6*d*. an ounce; and he laid in "a Pipe of Port, another of Madeira, and a Butt of Sherry, and twenty dozen of Claret for present use." The port cost from about 50*s*. to 64*s*. a dozen, the claret from 80*s*. or 90*s*. to 120*s*.; as in Mr. Spectator's day, "the plaguy French claret cost more money, and did less good."

By midsummer the Club had more than five hundred members. The Prime Minister, Lord Liverpool, and seven future Prime Ministers—Canning, Goderich, Wellington, Peel, Russell, Aberdeen, and Palmerston—were all in the first list. Five of these five hundred, including the celebrated Captain (Sir Edward) Sabine and Decimus Burton, the architect of the Club, were still members fifty-four years after; and the last survivor, Mr. John Lettsom Elliot, died in 1898, after seventy-four years of membership. The limit of numbers was very soon increased to 1000, and the rush of would-be members grew beyond all anticipation. The ballot became a severe ordeal, black-balls being so common that Mr. Humphry Ward finds it "difficul to understand how the Club managed to survive an prosper when such a nipping wind was prevalent i the years of its infancy." Men canvassed openly o their friends' behalf—a thing undreamed of now! W find Southey, for example, begging a fellow-member' vote and influence for "an old friend of mine—Kenyo is his name—one of the best and pleasantest men who I have ever known." This was Mr. John Kenyon, wh looked like Mr. Pickwick according to some, or like Benedictine monk according to others; and wa immensely popular "both in life and death," leaving great fortune to a large number of friends, among who Robert Browning's share came to 10,000*l*. In 183 very soon after the Club came into its own house, th celebrated Rule II. was passed, giving the committe power to elect nine eminent persons annually withou ballot. The first object of the rule was merely to sav a certain number of meritorious candidates from th risk and anxiety of the ballot; but it became a honourable distinction, and has given the bulk of i most distinguished members to the Club.

Decimus Burton, son of a prosperous London build (a rival of Cubitt's), was the remarkable man chosen, course by Croker, to be the architect of the new Clu

He was only twenty-four years old in 1824; but helped and protected by Nash he had already built the 'Colosseum' in Albany Street and several of the large houses in Regent's Park; and before he began to build the Athenæum (in 1827) he had built the Archway at Hyde Park Corner, the Wellington Arch on Constitution Hill, and other severely classical structures. Within three years, that is to say by 1830, the Club was built, at a total cost of about 43,000*l.*; it is vastly less than it would cost to-day, it is scarcely as much as the Club is obliged to spend on structural improvements on the renewal of its lease; but it seems a deal of money for men of science and letters and the arts to have spent upon their house a hundred years ago. The building looked just as it does to-day (and long may it remain so), save that it lacked the upper story, which was added some seventy years later. Croker conceived the idea of adorning the Club with its frieze from the Elgin Marbles; and he is said to have spent money on this embellishment which had been ear-marked for an ice-house. "I'm John Wilson Croker, I do as I please. . . . You ask for an ice-house, I give you a *Frieze*," is a well-known epigram by Joseph Jekyll, the wit of the first committee.

Mr. Humphry Ward's book falls into two parts. In the first part he describes the Club and sketches its history in a very charming fashion, with plenty of anecdotes and gossip and reminiscence, such as the theme invites and suggests abundantly; acknowledging his debt for much historical material, and repaying it handsomely, to the late secretary of the Club, Henry Richard Tedder. Tedder, who by the way had been a close friend and an executor of Herbert Spencer's, served the Club for more than forty years; the Club held him in the greatest possible respect, and a life-like portrait on the wall keeps him in its remembrance.

The second part of the book, which is all Mr. Humphry Ward's own, contains a list, with brief but telling annotations, of the members elected under Rule II. from the year 1831 until last year. It seems a little hard to exclude from commemoration *all* those who came in by the broad road of the ballot, who cannot all deserve neglect and oblivion; but the limitation set is at least a soundly conservative one, and the list as it stands is a wonderful catalogue of well-known names. The book opens in my hand, at random, at the year 1878. In that year came in Lister, and Rayleigh, and Frederick Harrison, and James Bryce; two great Anglo-Indians, Sir Alfred Lyall and Sir William Muir, both of them scholars and one of them a wit; Sir Robert Morier, "le grand ambassadeur qui a roulé Bismarck"; and last, but by no means least, Allen Thomson, the eldest of them all, a great anatomist and famous teacher, whose son still reminds us of him in the Club. Next year brought in Burne-Jones and Henry Sidgwick, and Stubbs the historian, and Stanley Jevons, and Huggins the great astronomer; also Lord Crawford, who succeeded Sir William in the chair of the Astronomical Society and was a true patron, if ever there was one, of science and of art; his son too is a member of the Club. In the following year we have Michael Foster and John Addington Symonds, and Salmon the Provost of Trinity, theologian, mathematician, and chess-player; also Lewis Morris and Orchardson, and Aldis Wright the great Shakespearian and learned Hebraist. Opening the book at another page we find that just fifty years before, Charles Darwin and Charles Dickens, Macready the actor, George Cattermole the painter, George Grote and Arthur Stanley, all entered the Club together in one special election by the committee. Mr. Humphry Ward's catalogue is well-nigh 250 pages long; the names cannot all be illustrious, but they are all more than respectable; they are the familiar names of the men who have made the world we live in, among whom have been our teachers and our friends.

Let us take a look within the Club, following, but not following too closely, Mr. Humphry Ward's description. The house is planned quite differently from the big house over the way. In the 'Senior' you look and look again for the stairs; but the great staircase of the Athenæum is the feature of the house. The pillars of the entrance-hall are copied from those of the Temple of the Winds; they are golden-yellow, on bronze bases, and the very sofas between them are of classical design. The floor is of a mosaic pattern; the recessed and panelled ceiling is enriched with delicate Pompeiian designs. The design and colouring are Alma Tadema's, who, together with Sir E. J. Poynter and Mr. A. Lucas, undertook the re-decoration of the Club in the early 'nineties. It is not in the taste of to-day, but it suits the architecture of the house to perfection; and it helps usefully to remind us that some things in Victorian art were exceedingly beautiful. On the Pall Mall side of the Hall is a pleasant morning-room. Time has ripened and softened a somewhat gorgeous ceiling, a rich Japanese wall-paper, and wood-work of a peculiar brown, of which last the club's earthenware teapots are said to have suggested the *motif*. There were some interesting pictures here until they were moved elsewhere not long ago. A portrait of Dr. Johnson by Opie was the gift (if I remember rightly) of Mr. Humphry Ward himself; it is as fine a thing as Opie ever painted, it reminds one of what he mixed his colours with, it shows Johnson as we would keep him in our mind's eye for evermore. Alas, it now hangs neglected on an unlighted wall; and its own place is filled by things incomparably inferior to it.

On the other side of the hall is the long dining-room, with a row of windows looking out upon the garden. The ceiling and mural decorations, by Sir E. J. Poynter, are curious but withal beautiful, and it seems an æsthetic solecism to hang modern portraits on the Pompeiian panelling of its walls. One knows where among the many tables one's friends are likely to be found—where men of science mostly sit, or where the artists or the critics; or the august corner where statesmen consort together, and eat and drink like common men. There are nooks and corners still associated by tradition with certain famous clubmen. Abraham Hayward, more than fifty years a member, friend of Sydney Smith and of Macaulay, translator of "Faust," story-teller, whist player and bon-vivant, sat in the corner by the door; was it not called "Abraham's bosom" even unto yesterday? In the same corner before Hayward's day sat Theodore Hook, drinking what (belittling it) he called 'toast-and-water,' and making up stories about bishops; and in the corner opposite, far-off in the south-west, J. M. W. Turner used to dine, and dine alone, and drink his bottle of port in semi-darkness after bidding the candles to be taken away. Charles Dickens is said to have used the same corner-table in after years. To go back for a moment to Hayward, he has very little to say about the Club in his published "Letters"; but curiously enough, it is from him we learn that Thackeray was blackballed in 1850, to be elected by the committee as soon after as possible, in the following year. Can it have been some old friend, or friends, of "Wenham" who did this thing?

As we turn to go upstairs we shall, perhaps, be shown just where Dickens and Thackeray made it up, after a long and bitter quarrel; Edmund Yates had satirised the satirist, and Dickens had taken sides with Yates. We shall be shown also where poor Dicky Doyle lay down and died—Dicky, who drew the immortal title-page of *Punch*, and signed it with his dicky-bird effigy. The great drawing-room, a Library (to the southward) and a Writing-room, all full of books, occupy the first floor. A fine bust of Croker, by Chantrey, is one of the ornaments of the drawing-room; Lord Rosebery and Mr. John Murray are said to have discovered it, and the committee had the good fortune to buy it for a small sum. In the South Library there is a big table in the middle of the room where Thackeray dictated Esmond (or parts thereof) to his friend Eyre Crowe; and Richard Burton sat afterwards at the same table, with his snuff-box beside him, translating the "Thousand and One Nights." In a corner of the same room was a favourite seat of Macaulay's, used afterwards by a line of scholars, by Hallam and Matthew Arnold, by Mark Pattison and by Lord Acton.

The Library (which Mr. Humphry Ward lingers over with obvious predilection) has been a feature of the Club from the beginning; books are here, there, and everywhere—in gloomy store-rooms, in basement passages, in dizzy galleries where few members are young or bold enough to venture life and limb. For sheer want of space accessions to the Library have been comparatively few in recent years; but books which no gentleman's library should be without are very plentiful, the older editions of the classics are all there, and there is a famous lot of the great illustrated folios once vastly admired by all persons of taste and fashion. Splendidly bound and enshrined in fine cabinets we find here such things as that monument of the Naples Bourbons, the great "Case e monumenti di Pompeii," or Graevius' "Thesaurus," or Hoare's "Wiltshire," or Gould's bird-books, or Temminck's still more beautiful "Planches coloriées"; or Brockedon's "Passes of the Alps," or Rossellini, or Stuart and Revett, and very many more. It was one of the chief objects and ambitions of the Library Committee when Henry Hallam was a member of it, about the middle of last century, to "purchase such works in the fine arts, in natural history and antiquities, as, though eminently instructive or interesting, are too costly or bulky for the majority of private persons." Many of us are old enough to remember the days when men (when we ourselves) loved and coveted such books as these, of which this strenuous, anxious generation takes no account at all; and are there not one or two (such as Sibthorp's "Flora Graeca") which we desire and covet still?

We might pass on from room to room finding associations everywhere and memories without end. We have not yet seen Faraday's wheeled chair, still standing as he left it; nor yet another and more famous 'Empty Chair'; nor Thackeray's terra-cotta statuette nor the Owls of Athene (several of them); nor the stone horse-block outside which was put there on purpose for the Duke of Wellington to mount at the door. But it is high time we took our leave of the Club, and of Mr. Humphry Ward's book. In doing so we may heartily declare that the book could not have been better done; it is light in touch, copious in anecdote, sympathetic in allusion, gentle in criticism. The Athenæum may well be proud of this history, and of the fellow-member who has put his heart into the writing of it.

And now what has been said in praise of the book becomes all of a sudden a tribute to its author's memory; for since these last words were written Humphry Ward's long life has drawn gently to its close.

D. W. T.

Popular Astronomy.

The Earth and the Stars. By Dr. C. G. Abbot. Pp. xi + 264 + 33 plates. (New York: D. Van Nostrand Co.; London: Chapman and Hall, Ltd., 1925.) 15*s.* net.

THE appearance of a popular work on astronomy, particularly one by so experienced a worker as Dr. Abbot, is an event of much interest to those who believe that science has a message for the general public, for there is no science which bears more closely than does astronomy on the intellectual problems that face all educated men. It is probably true also that no science can claim so copious a literature of the popular kind, but the rapidity and revolutionary character of recent advances has left the great bulk of astronomical treatises hopelessly behind the times. A book of the type of Dr. Abbot's is therefore anything but superfluous, and the reader will find in it information which even the publications of a year ago were too early to supply.

The general plan of the book is drawn, in the main, on conventional lines. Following a brief survey of the heavenly bodies and a chapter on "Some Famous Astronomers and Famous Instruments," the reader is given some idea of the order of magnitude of the electron and the stellar system, and the principle of the spectroscope is briefly described. It is doubtful whether the account of the processes of emission and absorption of light is sufficiently definite to be intelligible to the uninitiated reader. The earth, moon, and the sun's family then come under consideration, after which three chapters are devoted to the sun. Despite the title of the book, the sun claims more space than any other individual body—as, indeed, we should expect in a book by Dr. Abbot. He considers in some detail the possibilities of direct mechanical utilisation of solar energy, and is of the opinion that "there is, perhaps, no field where investigation is more needed, or more apt to produce useful results for mankind." A chapter on "The Calendar, Star Places, Navigation," is succeeded by some stories of the constellations, and the last four chapters are devoted to the system of stars and the stellar universe. These contain an outline of the chief facts which have been gleaned with regard to the stars and nebulæ, individually and collectively, concluding with a summary of the work of Jeans on the evolution of stars from spiral nebulæ and that of Eddington on the interiors of stars and the source of stellar energy.

The book concludes with six short appendices, giving notes on the solar eclipse of January 1925, and the tides, tables of data concerning the solar system and the first magnitude stars, a list of the constellations, and a comprehensive, non-technical dictionary of astronomical terms. The numerous figures and diagrams are mostly excellent, but one or two of the latter (*e.g.* Fig. 40, p. 196) are capable of considerable improvement.

The book is very interesting, and in spite of some digressions Dr. Abbot has managed to include a large amount of material in a well-arranged form. The information given is up-to-date, and has the general character and freedom from technical details which are desirable in a work of the popular class. There can be no hesitation in saying that the author has succeeded in his aim of producing a book helpful "to those who wish to acquire by easy reading a general survey of the universe they dwell in." A considerable number of pertinent anecdotes are included, and one or two the relevance of which is not so clear. The style is conversational—an excellent method of presenting a subject popularly, but one which, as here, may be followed too slavishly.

Conversation has, indeed, the advantage over the formal written statement in that it is alive, and holds the reader's attention more firmly, but it has defects which can and should be removed on revision. On p. 195, for example, we read: "We shall mention a little further on, perhaps, one or two other special parallax methods." The word "perhaps" here is excusable when spoken, for the fulfilment of the promise may depend on time or some such limitation, but it is surely superfluous on the printed page. Another preservation of the defects of conversation is to be found in the frequent repetitions of turns of phraseology or playful asides. Thus on p. 92 we read, *à propos* of the sun: "No star could have obeyed better the spirit of the advice of Robinson Crusoe's father to stick to the middle class as the happiest," and on p. 226 the same comment occurs again. So common, indeed, are such repetitions that we soon learn, on encountering an illustrative saying of this kind, to await its recurrence with a confidence which is rarely unjustified. Nor is it only such phrases as these that are reproduced; the same lack of critical revision is evident with respect to plain statements of fact, *e.g.* Kepler's laws, which are thrice set out on pp. 9, 13, and 68. The several occurrences of the same statement do not always agree; as, for example, the definition of the precession of the equinoxes, which on pp. 14, 20 and 55 and in the glossary is rightly given as a westward movement, and on p. 7 as an eastward movement; or the three accounts of the distribution of novæ in the sky on pp. 182, 212, 223. This feature of the book is much to be regretted, inasmuch as a very little care would have removed it and brought about a vast improvement.

A few slips occur, of varying degrees of importance.

Spectrum lines from the sun's western limb are said to be displaced to the violet instead of to the red (p. 73). On p. 94 we read: "Eddington has shown it to be probable that . . . light pressure . . . actually prevents the existence of any stars of masses more than five times the sun's mass." In another connexion, however, the existence of more massive stars is referred to. We are surprised also to find the discovery that flame, arc and spark spectra of the same element are different in character attributed to Gale and Adams (p. 101); surely Lockyer's work can no longer be ignored.

There is one other point which it is important to mention. In two or three places occur statements which, considering the character of the book, we think too dogmatic. Thus we are told on p. 85 that Clerk-Maxwell *proved* (instead of *predicted*) theoretically that light exerts a pressure on small particles. No physicist, of course, would misunderstand this, but the man in the street is entirely dependent on the statements of specialists, and the word "proved" is for him final. He would be surprised to learn that on the same principles it could be "proved" that the atom is unstable and the universe cannot exist for a day. Again, on p. 214 it is stated definitely that Cepheids are not double stars, and on p. 222, spiral nebulæ are described without qualification as "island universes."

It is regrettable, though necessary, to direct attention to so many blemishes in a book which has given us great pleasure. The faults are mostly of a trivial character, but taken together become of considerable importance. Fundamentally the book is excellent, both in matter and in form; what it suffers from is lack of a final revision. It is greatly to be hoped that this will be supplied in the next edition. H. D.

Comparative Morphology of Fungi.

Vergleichende Morphologie der Pilze. Von Ernst Gäumann. Pp. x+626. (Jena: Gustav Fischer, 1926.) 28 gold marks.

THE need for a good and well-balanced treatise on the morphology of the fungi, incorporating the results of modern work, is one that has, no doubt, been felt by many botanists in recent years, and the present book comes nearer to meeting it than any that has hitherto appeared. One may, perhaps, regret that so much space is given to cytological details, but this is inherent in the author's expressed object, namely, to apply the data obtained from cytological studies to the interpretation of the problems of comparative morphology in the fungi. This method of treatment leaves comparatively little room for the consideration of the fungi as living organisms, adapted to their surroundings: physiology is not touched on; and life-histories are scarcely described except as incidentals to the cytological story. As a result, the imperfect forms of fructification are relegated to the background and the Fungi Imperfecti as a whole are dismissed in four pages. These, however, are the author's self-imposed limitations and are not open to criticism, however much they may be regretted.

The book is divided into a short opening section on the vegetative and reproductive organs of the fungi, and a main part, in which a detailed account is given of the morphology of the four classes, Archimycetes, Phycomycetes, Ascomycetes, and Basidiomycetes. The heterogeneous class of the Archimycetes, containing the Olpidiaceæ, Synchytriaceæ, Plasmodiophoraceæ, and Woroninaceæ, is derived from various roots in the Sporozoa-Flagellate-Myxomycete alliance, while the rest of the fungi are regarded as a single phylum, originating, in all probability, from the green algæ. The Oomycetes diverged early to a blind end, the Chytridiaceæ progressed through the Zygomycetes (Endogone-like forms) to the Ascomycetes and Basidiomycetes.

The Hemiasci are considered to form the connecting link between the Zygomycetes and Ascomycetes proper and are divided into two orders, the Endomycetales (including the yeasts) and the Exoascales in which are grouped the two isolated and not completely understood families of the Protomycetaceæ and Exoascaceæ. The gradual reduction of sexuality in the Ascomycetes affects chiefly the male gametes, which become functionless and disappear, their place being taken by secondary spores or by cells of the female organ; with the loss of the latter, conjugation between two vegetative hyphæ may be all that is left of the sexual act.

Where the author's views diverge from those of others who have concerned themselves with the phylogeny and comparative morphology of the fungi, he has indicated and explained the differences in their points of view, while the copious literature references have been selected especially to include those in which detailed bibliographical accounts of earlier work may be found. In such matters as the derivation of the Oomycetes from the algæ, he takes only the balance of probabilities as he sees them, and there is a refreshing absence of dogmatism throughout the work. It is stiff reading, owing to the very full documentation and the great extent of the literature covered, but the arguments are clear and the descriptions of the forms selected to represent the different families are concise and admirably illustrated. The author is to be congratulated on his excellent presentation of a most difficult subject.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Electrical Constitution of the Upper Atmosphere.

RECENTLY considerable interest has been evinced in the nature and constitution of the upper atmosphere (NATURE, March 13), and it has been suggested that wireless methods are perhaps the most effective in exploring this region.

In this connexion the following facts, and possible explanations, may be of interest. In a recent paper in the *Philosophical Magazine* (June 1925) the writer suggested that a certain type of atmospheric disturbance which is semi-musical in nature, *i.e.* consisting of a musical note the pitch of which falls to a limiting frequency n_0, may throw some light on the electrical constitution of the upper atmosphere. The interpretation suggested was that these disturbances owed their musical nature to the dispersive action of the medium, which was assumed to consist of an assembly of electrons in a rarefied atmosphere. Such a medium will have the effect of transmitting different frequencies with different velocities, with the result that the spectrum of frequencies comprising an impulse is drawn out into a musical note of varying frequency.

It was shown that the lowest pitch of the disturbance is determined by the relation

$$n_0^2 = \frac{Ne^2}{\pi m},$$

where N is the number of ions per c.c., e is the charge on an ion, and m the mass of an ion. This is what I call the characteristic frequency of the medium.

In some experiments about a year and a half ago I found the prevailing characteristic frequency to be from 300 to 500 a second. In making some recent tests I noticed that the prevailing characteristic frequency had risen two or three times, suggesting a four to tenfold increase in the ionic density. Associated with these changes there has recently been an increase in sunspot activity, magnetic storms and an auroral display so far south as London, and a noticeable falling off of the strength of short-wave signals from America. There seems little doubt that these are all associated with the approach of the period of sunspot maximum in 1928, especially in view of the theoretical deduction that such an increase in ionic density must necessarily increase the attenuation for night transmission if the constitution of the layer is as assumed above, provided the time period of the waves is short compared with the mean time between electronic collisions with molecules. Further evidence in confirmation of these views is afforded by measurements of trans-Atlantic telephony signals on a wave-length of 5270 m., published in the *Bell System Technical Journal*, July 1925. It is there shown that the average night strength of signals is largely decreased during magnetically disturbed days, a fact which is in accord with the foregoing theory, and confirms the hypothesis that the recent reduction of short-wave signal intensity is due to the sunspot activity.

It seems also probable that the explanation of the musical atmospheric disturbances given by the writer is substantially correct, and that observations of these will provide additional data for determining the electrical constitution of the upper atmosphere.

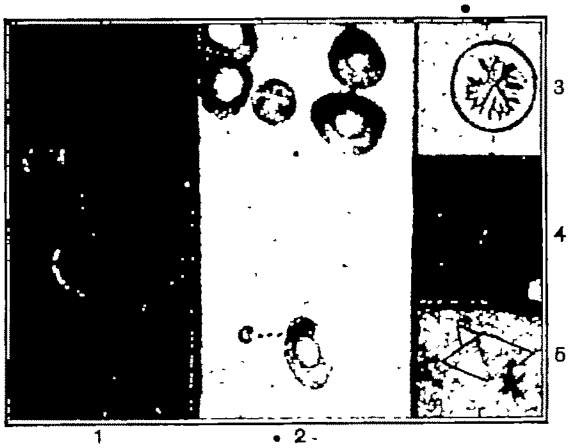
T. L. ECKERSLEY.

Research Department,
Marconi's Wireless Telegraph Company, Ltd.,
Marconi Works, Chelmsford,
May 25.

Hydrolysis of Starch Grains by Light Polarised by Small Particles.

DURING the last three winters I have been engaged in an experiment, which throws additional light on the work described in a former paper (Baly and Semmens, *Proc. Roy. Soc.* B, 97, 250), and as the effects took place in a small flask, disposes of the 'accidental pressure' hypothesis of critics.

The well-known scattering and polarising effect of colloidal particles suggested the use of a suspension of diastase as a polarising agent, and the experiment was thus arranged: About 10 cc. of a suspension of well-washed potato starch in distilled water was placed in a small thin-walled flask (A), and this was immersed in a beaker containing a strong colloidal solution of taka-diastase. As control, an equal quantity of the starch suspension was used, contained in a flask (B), which was lightly waxed, to depolarise any reflected light. The outer vessel in this case contained tap-water. The necks of both flasks were plugged with cotton-wool dipped in toluene, and the vessels were exposed for several days in a window at the top of a tall building, to catch the horizontal rays of the morning and evening sun.



Potato starch grains in distilled water after exposure to polarised light.

1. Exposure two days; examined and photographed immediately after bright afternoons.
2. After less intense exposure; on partial drying, change inside grain is shown, canals (c) to exterior forming.
3. Exposure four days; crystals forming inside grain. (× 300)
4. Exudation from holes in coat beginning to crystallise. (× 200.)
5. Bunch of crystals from single grain—with crystal plates.

The light polarised by the particles of diastase was thus reflected vertically upward and irradiated the starch grains lying at the bottom of the inner vessel (A). The control received direct light through a cleared space in the waxed surface of B. The results were tested at intervals of two or three days by examination on a microscope slide and were as follows:

(1) Immediately after a bright sunrise or sunset, many of the grains in flask A were found to be rapidly breaking (Fig. 1) while in flask B they were practically intact.

(2) If the weather were dull or the examination delayed, the grains merely showed a transparent streak in the centre, which gradually extended and formed little canals to the exterior (Fig. 2) through which the contents exuded, leaving the shrivelled skeleton or coat.

(3) When some of the liquid was mounted on a microscope slide with cover glass and left to dry in the dark, a film was formed showing diffraction fringes and crystals slowly formed in the liquid.

(4) Occasionally the hydrolysed-contents crystallised within the grain (Fig. 3) or exuded from it, leaving the tiny shell in the centre as in Fig. 4.

(5) After prolonged exposure the empty shells or coats break down to a fatty substance (giving black or brown with osmic acid and red with Sudan III.), and rhomboidal or hexagonal plates are left near the crystallised grain-content (Fig. 5). These plates are often very thin, and in this case the outline in the photograph was slightly darkened for reproduction in print. On boiling with Fehling solution, the contents of flask A gave a distinct change of colour, which was not visible in B. Specks of cuprous oxide were also seen within the partially hydrolysed grains from A.

It would be premature to discuss the theoretical significance of these results, but they seem to indicate that in the action of certain enzymes, beside the quantum factor in energy absorption, there is also an orientation factor. As physiological reactions take place at surfaces, there must be some correlation between the orientation of the vibration and the molecular arrangement at the surface.

I wish to express my indebtedness to Sir James Irvine for valuable suggestions and criticisms, and, as always, to Prof. E. C. C. Baly for his continued help and encouragement.

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Upper Air Temperatures and Thunderstorms.

IN NATURE of November 14, 1925, p. 709, I directed attention to the method of plotting upper air temperature readings by the use of temperature and log. potential temperature as co-ordinates, the curves being designated tephigrams by their inventor, Sir Napier Shaw. It may be recalled that, by the use of these curves, the energy available from a mass of air rising under unstable conditions is shown directly as an area on the graph. Opportunity has now been taken to study these diagrams in connexion with thunderstorms in the south-east of England during the three months June, July, and August of last year, and the results obtained are of interest.

Aeroplane ascents are made daily (Sundays excepted) by the Meteorological Flight at the Royal Air Force Station at Duxford, near Cambridge, on which dry and wet bulb temperatures are read at each 50 mb step of pressure from 1000 or 950 mb up to the highest point reached. This is generally in the neighbourhood of the 500 mb. isobaric surface (18,000-20,000 feet height). From these readings the humidity of the air is calculated Unfortunately the wet bulb thermometer becomes useless soon after the aeroplane passes through the 32° F. isothermal surface, owing to the impossibility of keeping the bulb moistened, but it does not appear that humidities above this level are of very much importance in the formation of thunderstorms, so that the drawback is not a serious one for the present inquiry. To obtain a quantitative measure of the energy available from a mass of ascending air, it is necessary to know the temperature conditions existing in the atmosphere up to the point where the rising air loses its buoyancy and comes to rest, and this point is generally in cases of marked instability above the level to which areoplanes can fly as a matter of day-to-day routine. The investigation has therefore had to be on a qualitative rather than a quantitative basis, but from the data studied it appears that this is sufficient to give results of great value.

In the three months, 71 days were available on which an aeroplane ascent was made, such ascent normally taking place at about 8.30 A.M. in the morning. In a few cases where no morning ascent was available an afternoon one was utilised, but as the inquiry was mainly directed to the utility of the method for the forecasting in the early morning of thunderstorms during the coming day, the morning readings were primarily used. The three months varied in character; June had only one day of thunder, while July was thundery with 12 days, and August took an intermediate position with 9 days. The method of plotting humidity on tephigrams was discussed in my previous communication, and the proposal there put forward has been followed and has proved very satisfactory. It is clear that on a day of instability the air in each layer of the atmosphere will, in rising to its equilibrium position, develop its own amount of energy, and some one layer will on each occasion show maximum potential energy. This energy is very closely dependent upon its humidity and the heat liberated by condensation. It is easy on tephigrams to see which layer gives this maximum energy without plotting the relative humidity of every layer, and for each ascent the humidity has only been plotted at the layer which shows maximum energy on days of instability or the nearest approach to a development of energy on days when stable conditions prevailed. In this way the diagram is kept free from complication and the degree of energy available is seen at a glance.

The 71 days were divided into days of no thunder and days of thunder, the latter division containing all days on which thunder was reported from one or more of the stations contributing to the Daily Weather Report in the south-east of England, broadly defined in this case as the area south and east of Birmingham. The thunderstorm must thus have occurred within a radius of about 100 miles of Duxford. A cursory glance at the tephigrams indicated the closeness of the connexion between energy available and thunderstorms, and a more detailed study showed that the 71 days might be divided into three classes, only 7 cases remaining which did not fall readily into one of these classes

Class A *No energy and no thunder*. This contained those cases where there was no thunder, and either no energy was shown or there was energy only in a shallow layer below a layer of marked stability (36 cases).

Class B. *Energy high up generally without thunder.* In these cases energy was available, but not below the 700 mb. isobaric surface (say 10,000 feet) (13 cases). In 10 of these cases there was no thunder. In the remaining 3 cases there was thunder, but in 2 of these an evening ascent showed that later in the day energy was available at a lower level (below 700 mb.), so that the days might have been put into Class C below.

Class C. *Energy with thunder*. In this type energy was available below 700 mb., and was associated with subsequent thunder (15 cases).

These classes thus cover 64 out of the 71 cases and indicate a very close connexion between the energy shown on the tephigram and the subsequent development or non-development of thunder. The 7 cases not included in the above three classes represent only

10 per cent. of the whole, and it is not necessary to discuss them here in detail. They consist of—(1), 3 days when energy was available below the 700 mb. level, though thunder was not reported, and (2), 4 days with thunder, though little or no energy was shown. As regards (1) it must be remembered that thunder may occur but escape the network of Daily Weather Report stations; and as regards (2), Duxford will not always be typical of the air over the south-east of England for the remainder of the day.

As regards Class B, it is scarcely surprising to find that energy developed above the 700 mb. level is ineffective in producing thunderstorms, when it is remembered that the moisture content of saturated air above this level is comparatively small.

The close association between energy and thunderstorms shown by these ascents is most encouraging for the forecasting of thunderstorms and gives further proof, if such were needed, of the importance of regular aeroplane ascents to a modern forecast service. J. S. DINES.

Meteorological Office,
Air Ministry, May 13.

New Experimental Results concerning the Doublet $K\beta_1$.

IN a communication under this title in NATURE of April 17, p. 554, N. Seljakow and A. Krasnikow have inferred from measurements on the lines $K\beta_1$ and $K\beta'$ in the Röntgen spectrum of manganese, that they form a relativity doublet characterised by the energy difference $M_{II} - M_{III}$. Now with molybdenum the corresponding difference is about 0·8 $\frac{\nu}{R}$ units, whereas with elements of lower atomic number similar measurements have so far not been published. The very small value found for molybdenum makes it reasonable to suppose that, for the elements between calcium and zinc in the periodic system, the corresponding energy difference would not give rise to any separable lines. For even if we assume the appearance of 3_3-orbits, which begin with scandium, to cause a disturbance in the M-level, so that the 3_3-orbits are unequally screened for this and the next element, it still follows from an approximate calculation that this effect cannot possibly give rise to a larger difference than about one-third of that actually measured. On the other hand, the broadening of the $K\alpha$-doublet of iron found by Siegbahn and Ray (*Ark. Mat., Astr. Fysik*, vol. 18, No 19) and recently studied by Thoraeus (*Phil. Mag.* (7), vol. i. p. 312, 1926), which represents a much smaller value of the energy difference, may well be attributed to such a screening effect of the 3_3-orbits, as this would, of course, be equivalent to a slight increase of the nuclear charge.

With the $K\beta$-lines, the interpretation of the doublet as due to a relativity effect would doubtless require a more detailed explanation. The intensity ratio $\beta_1 . \beta' = 2 : 1$, which supports this interpretation, appears so far to have been definitely established only with manganese (N. Seljakow and A. Krasnikow, *Zs. f. Physik*, 33, 601, 1925). Investigations by the writer carried out in this Institute seem to prove that with iron in compounds the intensity ratio (estimated) has also approximately the same value, *i.e.* 2 : 1. With titanium and vanadium, however, a value considerably larger than 2 : 1 was found.

Seljakow and Krasnikow also state that the intensity ratio $\beta_1 : \beta'$ is not sensibly affected by passing the rays through foils of the same element. A similar observation on the satellite lines in the L-series of the rare earths has been described by D. Coster (*Zs. f. Physik*, 25, p. 98, 1924). This fact supports the view that the K- or L-electron is completely removed from the atom in the absorption process. Moreover, the explanation suggested by G. Wentzel (*Ann. der Physik*, 66, p. 458, 1921), who attributes the satellites to supernumerary excess electrons in the M-level, does not appear to be refutable on this basis.

Another point should be noticed in this connexion. The elements of the rare earths offer many analogies to those between calcium and zinc. A 4_4-orbit occurs for the first time with cerium, where also the β_{14} and γ_9 lines have been found by D. Coster to accompany the β_2 and γ_1 lines, as satellites of lower frequency. The increase in intensity of these satellites with increasing atomic number appears to be closely analogous to that of the β'-satellite for the elements next to iron. On the other hand, a cursory examination of the energy levels of the rare earths seems to exclude a relativity explanation of the satellites in the case of cerium and the following elements.

The interpretation of the $K\beta_1\beta'$ lines as a relativity doublet, offered by the Leningrad physicists, appears therefore scarcely admissible, whereas the hypothesis of Wentzel seems to be in better agreement with the experimental facts. If we try to estimate the effect of the supernumerary electrons involved by this hypothesis, we are led to the conclusion that such electrons cannot be limited in number to only one, otherwise we must assume rearrangements of the electron groups to occur. Especially the fact that the β'-line appears sensibly broadened seems to exclude a normal energy level as the origin of this line, and to support the view that several kinds of radiating atoms may co-exist, these differing from each other in the number or arrangement of their electrons within the M-level G. ORTNER.

Institut fur Radiumforschung,
Wien, May 10.

Wasteful Research?

THE issue of NATURE of May 1 contains a letter by Messrs. Morgan and Holmes from the new government "Chemical Research Laboratory, Teddington," describing results of their study of certain fatty materials. I venture to ask directly and plainly: Why is such work being done in a State laboratory? Years ago there was much heartburning among consulting chemists because the National Physical Laboratory was taking the bread out of their mouths. Is it now to be the turn of the universities and technical schools to suffer from the State poacher? The work described is purely academic, such that any intelligent fourth-year student could do.

To-day the chemical schools are in large part engaged in so-called research which is of no consequence and often detrimental as training—clearly because they are led by men without practical outlook. These need even to have practical subjects of study forced upon them, which will afford their students training in laboratory methods. With scarcely an exception, the real work that is being done in chemistry is with materials of natural origin. Fats are among them. A special technical professorship to deal with these has only recently been established in Liverpool, and is in specially able, experienced hands. Another of the professors in that University, only a month or two ago, made known the results of several years' close study of perhaps the most remarkable fat yet examined—that from shark's liver. The inquiry is probably the most finished and meritorious piece of work of the day. Sir William Bragg's school has scored its chief triumph off fats. Sheffield studies them rather than iron. Last, not least, one very expensive organisation of the Department of Industrial and Scientific Research has fats specially under its charge. It has a habit of putting its work out, and some has already been placed with the University of Manchester. So it is clear that even the university may be trusted with fat. Why, then, further workers and new buildings in a field already so fully occupied?

Every halfpenny spent thus wastefully by State agencies out of the grant from the State is money withdrawn from the schools of experimental science, to which the grant was primarily made, to enable them to prosecute original inquiry and train a research force for the service of the State. The future of higher scientific inquiry is being gravely imperilled by the bureaucratic machinery which is fast closing its clutches upon our scientific liberties. We are false to the trust that is imposed on us if we further countenance a system which not a few of us regard as indefensible. The nation cannot afford to waste money in any quarter to-day, nor should it be led into thinking that it is getting special service from a Department which is showing that it is technically unfitted for the work it has undertaken. I may instance particularly fuel research, upon which half a million sterling seems to have been spent without result, mainly because practical needs have never been taken into account and existing knowledge and experience put aside.

HENRY E. ARMSTRONG.

May 2.

The Anomalous Flocculation of Clay.

IN NATURE of May 1, p. 624, there appears a letter from Dr. A. F. Joseph and Mr. H. B. Oakley regarding the so-called anomalous flocculation of clay. We should like to point out, however, that it is doubtful whether the experiments referred to in the first part of the letter could be expected to show anomalous flocculation as ordinarily understood. In the first place, it has been suggested by Comber (*Journ. Agric. Sci.*, 1920, 10, 432; *loc. cit.*, 1921, 11, 460 *et seq.*; and *Trans. Faraday Soc.*, 1922, 17, 349) that the phenomenon referred to is dependent on the presence of colloidal silica in the outer surface of the particles, and the "highly purified clay" used by Dr. Joseph and Mr. Oakley might well have lost this coating. Further, the phenomenon is shown, not so much by differences in the minimum amount of ion required for flocculation, as by an increased rate of sedimentation when a sufficiency of the ion is present. It would be interesting to know whether the particular clay used would show the phenomenon of anomalous precipitation at higher concentrations of salts either alone or after the addition of colloidal silica.

It may be mentioned that with suspensions of kaolin we have obtained very marked anomalous precipitation in alkaline solution by calcium ions after the addition of small quantities of colloidal silica, although these suspensions did not exhibit this phenomenon when silica was not present. We have also observed a similar effect with cæsium chloride, although in this case the phenomenon, under certain conditions, may be delayed for approximately 24 hours. Ammonium and potassium salts give similar results after still longer delays. The effect seems to be related to the precipitating action of the cations of these salts on colloidal solutions of silica at *p*H greater than 7,—a phenomenon which appears first to have been described by Pappadà (*Gazzetta Chim. Ital.*, 1903, 33, (ii.), 272). The nature of the precipitate in this anomalous flocculation is quite different from that obtained at other concentrations of the ions and other reactions of the medium. For example, in the case of calcium chloride a voluminous and highly flocculent sediment separates in the first two or three minutes at concentrations exceeding 39×10^{-4} *N* and at *p*H 8–9. At the end of such periods there is practically no flocculation apparent at corresponding concentrations of the salt in neutral or acid medium, or at any reaction or concentration of salt when silica is not present.

W. O. KERMACK.

Royal College of Physicians'
Laboratory, Edinburgh.

W. T. H. WILLIAMSON.

Edinburgh and East of Scotland
College of Agriculture,
Edinburgh.

Major-General William Roy.

REFERENCE was made in NATURE of May 1, p. 630, to the life and work of Major-General William Roy. It is stated in the note in question that Roy entered the army at twenty years of age; his own statement is that a "body of infantry was encamped at Fort Augustus in 1747," when he was twenty-one, and that "as Assistant Quarter-Master it fell to my lot to begin . . . the execution of that map." It appears that he held a minor position in the Post Office at Edinburgh until 1747. As to the date of his joining the army, Mr. George Macdonald, in his valuable study "General William Roy and his Military Antiquities of the Romans in North Britain," published by the Society of Antiquaries in 1917, states that it is quite possible that Roy was not in the army at all during the construction of the map of Scotland. All that we know for certain on this point is that Roy was appointed Practitioner Engineer on December 23, 1755.

No mention is made in the note of Roy's archæological work. As a fact, throughout the whole of his life he was deeply interested in the history of the past, and he is probably nearly as well known as the author of the "Military Antiquities" as he is as the founder of the Ordnance Survey. It may interest readers of NATURE to know that the terminals of the base which he measured on Hounslow Heath in 1784 were replaced by guns buried vertically, muzzles upward, in 1791, and that these guns still remain in position.

C. F. CLOSE.

Coytbury, Winchester, May 25.

Hydrogen as Anion.

WE are all so much entertained by Prof. H. E. Armstrong's broadside attacks that those of us who happen to come within his range must not complain; but I feel that I must protest against his criticism (NATURE, April 17, p. 553) of the beautiful experiment of Bardwell which proved that hydrogen is an anion in metallic hydrides (*J. Am. Chem. Soc.*, 44, 2499 (1922)). If Prof. Armstrong would read carefully Dr Bardwell's paper he would see what pains were taken to separate the anode and cathode chambers, and since hydrogen was evolved quantitatively at the anode it could scarcely be due to liberated alkali metal unless this also were set free at the anode—which even a thorough-going opponent of physical chemistry would scarcely assume. This being so, it is perhaps unnecessary to mention the bald chemical fact that the alkali metals do not in any case react with metallic hydrides to set free hydrogen.

GILBERT N. LEWIS.

Berkeley, California, April, 29

The Steel Industry.[1]

By Sir William Peter Rylands.

As there are now indications that the world has made some definite progress towards a return to normality, this occasion is not inappropriate for presenting a picture of the past history of the steel industry, so that it may help in forming some reasoned judgment as to future prospects. For this purpose, with the assistance of Mr. Lloyd, I have prepared a chart (Fig. 1), and in this connexion I desire also to express my thanks to Sir William Larke for the valuable information he has placed at my disposal. In this chart I have set out four main curves, one representing the total of the world's production of steel, and the other three the respective annual productions of the United States, the Continent of Europe, and of Great Britain. I had expected to find a steady development in the world's consumption of steel, but I must admit to a feeling of some amazement when the curves were finally plotted out.

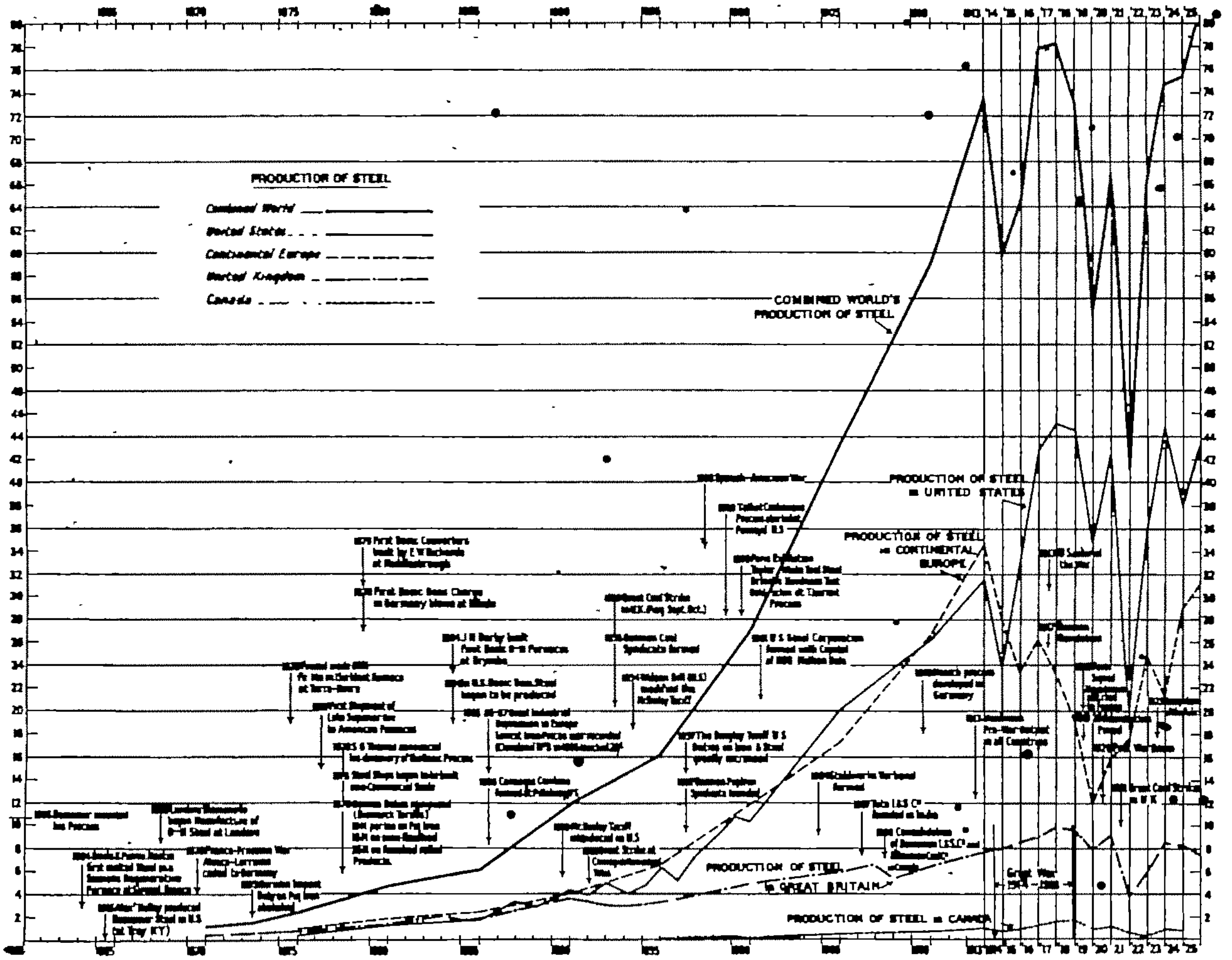

Fig. 1.—The world's production of steel, 1870–1926.

Measured in terms of present consumption, the total production of steel was almost insignificant up to forty years ago, and the year 1885 may be taken as marking the commencement of what may fairly be described as the 'Steel Age,' for which the discovery and development of the basic process was so largely responsible.

The most striking feature in the curve of the world's production of steel is the extraordinary uniformity in the rate of increase. Periodical fluctuations which must have taken place are entirely obscured in the curve plotted as a bold line, and up to 1914, instead of any inclination for the rate of increase to diminish, the curve tended continually to become more steep. It is difficult to avoid the conclusion that had the normal development of the world not been interrupted by the War, the world's consumption of steel would have continued to increase at a rate not dissimilar from that previously experienced, and might to-day have exceeded 100 million tons per annum.

In addition to certain subsidiary points of interest from which useful deductions may possibly be drawn, the curves bring to the eye three other main features. The first is the disturbing effect of the War, as illustrated by the curve movement between 1913 and the present time; secondly, the extraordinary similarity of the total production of the United States and the Continent of Europe respectively during the pre-War period; and thirdly—a matter with which Great Britain is peculiarly concerned—the failure of Great Britain to maintain her position in relation to the United States and the Continent. Until the year 1890 the respective productions of Great Britain, and United States, and the Continent of Europe were approximately the same. Thereafter, the production of steel in the United States and on the Continent grew with amazing rapidity, while the production of Great Britain, although increasing, increased at a rate in no way comparable with the general increase in the world's demand.

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[1] From the presidential address to the Iron and Steel Institute, delivered at the annual meeting on June 3.

In spite of the unsatisfactory condition of the steel industry during the past few years, the curve seems to suggest that the pre-War rate of expansion of the world's consumption has been approximately restored, and encourages the hope that in the next ten years an expansion even to the extent of thirty million tons a year is not beyond the bounds of possibility, or indeed of reasonable anticipation—an expansion which would go far to solve many of the troubles from which the industry is suffering. Unfortunately, ten years is a long time, and British steel-makers, at all events, are much concerned to know what proportion of that estimated increase will fall to their lot, and how soon they can hope for a demand for British steel equal to British capacity to produce.

Many, if not all, the difficulties of basic industries are to be attributed to an arrest for practically ten years of the normal growth in the world's demand, an arrest which, unfortunately, was not accompanied by an arrest in the rate of increase in instruments of production. In the case of the steel trade, and other industries vitally concerned with the supply of munitions, there was in many countries a direct stimulus to an increase in plant, and an improvement can scarcely be expected until that increased capacity is absorbed.

The curve of the United States production indicates that the capacity of that country both to produce and consume continued to grow during the period of the War at approximately the pre-War rate, and the market in the United States being such a large factor in the world's demand for steel, it is manifest that the total world's demand must be greatly increased before there is any surplus demand available for the benefit of the European manufacturers.

Production on the Continent, after sinking to the depths of the post-War depression, has steadily risen, and in 1925 was but little short of the aggregate production of 1913. There is, however, a large amount of plant on the Continent still lying idle, of an estimated capacity of ten to fifteen million tons per annum, which can only be brought into operation by a corresponding increase in the world's demand.

The production of the United States in 1925 exceeded the highest level reached before the War by more than ten million tons, and to absorb this increase and to occupy the idle European plant and provide for a normal increment in the steel requirements of the United States, there must be an increase in the world's demand of at least thirty million tons, or, say, ten years' increment at the remarkable rate of increase experienced prior to the War.

It is difficult to avoid the conclusion that the pressure of competition from the Continent during the next ten years must continue to be very severe. In this connexion we must bear in mind that there are many new developments in steel manufacture in other countries of the world, and this increase in local production must diminish the share of the world's demand available to the old steel-producing nations.

Up to this point we have discussed the prospects of the steel industry, particularly from the point of view of the United States and the Continent of Europe, but we here are more intimately concerned with the well-being and future prosperity of the industry in Great Britain.

I have already directed attention to the regrettable feature in the curves showing that from 1890 onwards Great Britain secured a negligible share in the increase of the world's steel trade. Another regrettable feature is indicated in the closing years covered by the chart. While the world's demand, the production of the United States, and the production on the Continent showed during those two years a healthy and encouraging improvement, the production of Great Britain steadily fell, and if the suggestion is well founded that we cannot reasonably hope that the world's demand will, in less than ten years, overtake the world's capacity to produce, the present trend of British production must give rise to feelings of profound anxiety.

It is no doubt true that, owing to the depreciation of the Continental exchanges, and the lag in internal values, as compared with world values, the Continental manufacturers have enjoyed an artificial advantage in competing with Great Britain, both in the British home market and in the markets of the world, and that we may hope that, in the course of a year or two, this lag will disappear and Great Britain will no longer suffer from that peculiar handicap. Unfortunately, pre-War experience does not encourage us to anticipate that even under pre-War conditions—if these are to be regarded as the conditions of normality—British steel manufacturers will be able to compete with that success which present circumstances would seem to demand.

Prior to the War the heavy competitive trade passed largely into the hands of the manufacturers on the Continent and in the United States, while such increase as was, in fact, secured by the British steel industry, was rather in the direction of special lines and special qualities, and with the assistance of special conditions. Even for the home requirements of billets and sheet bars a large proportion was imported from abroad.

Clearly, with the great increase in British steel-making plant, it is now essential that the British steel manufacturers endeavour to secure a greater share of the heavy competitive trade, since it is doubtful whether any increase in the world's demand which can be anticipated during the next ten years will be accompanied by a sufficient increase in the special trades where Great Britain enjoys some peculiar advantage. Otherwise, without a serious reduction in productive capacity, the conditions of the British steel industry may be difficult for a considerable number of years to come.

These reflections invite consideration as to the reason why Great Britain failed to maintain its share in the general expansion of the world's trade, and after maintaining its position for twenty years up to 1890, thereafter was left behind in the race.

Great Britain was the cradle of the steel industry. Some of the most revolutionary advances in technique originated in Great Britain. There were bountiful supplies of cheap coal, and although the Minette ore fields were of great assistance to the German industry, much of their steel was made from ore derived from other sources, presenting no particular advantage.

No doubt the United States derived great advantage from their immense and expanding home market, but it is a notable feature that the increase in production on the Continent kept pace step by step with the corresponding increase in the United States, and it is not easy to appreciate the exact advantage enjoyed by the Continent of Europe over those who conduct the industry in Great Britain.

Examining once more the history of the steel industry, it will be noted that its early development following on the introduction of the basic process was accompanied by a serious trade depression—a depression experienced not only in Great Britain, but also shared by the United States and the Continent. Between the years 1885 and 1887 the price of Cleveland iron reached the lowest figure ever recorded.

Two important factors developed both in the United States and on the Continent approximately at that time: the first was the definite adoption by both the United States and Germany of a tariff policy designed to protect the home market; the second, arising without doubt out of the depressed condition of the industry, was the development of a high degree of internal organisation of the trade in both those countries. At the depth of the depression the Carnegie Group was formed in the United States, followed later by the United States Steel Corporation, while in Germany syndicates were created for controlling the coal, pig iron, and finally steel, by means of the Stahlwerks Verband. It would not be appropriate to lay any stress upon the desirability of an import duty, or to draw any deduction as to the advantage which accrued from that policy to the industry in the United States and in Germany. This is a matter of political controversy. We are on safer ground if we argue that organisation was the responsible and dominant factor.

In few, if any, other industries are the costs of production so profoundly affected by large scale output and continuous operation as in the industries of steel and coal, and I am strongly convinced that the remarkable success of Germany and the United States in securing the lion's share of the increasing world's demand for steel is to be attributed to organisation directly aimed at securing that result.

As an illustration, on a visit to Germany in 1912, I was informed that the cost of producing mild steel billets in Westphalia exceeded 80 marks per ton, approximating very closely to the cost of manufacture in Great Britain. Those same billets were delivered to buyers in England at a delivered price of less than 4*l.* per ton, and having regard to the cost of carriage, it was manifestly impossible for the British manufacturers to compete.

No doubt the pursuit of special qualities is not entirely compatible with the policy of large and standardised production, and so long as the capacity of Great Britain can be satisfied by special business of this kind, and the manufacturers concerned are content, a valuable and important industry can be maintained; but if, as appears now to be essential, Great Britain is to secure a greater share of the world's steel trade, a different policy is imperatively demanded.

The commercial greatness of Great Britain was largely founded upon its production of coal and steel, and if that industrial position is to be maintained, the problem should be approached from the broadest point of view in the interests of the country as a whole. Some national responsibility attaches to the steel-makers. It is not enough that a few steelworks should be conducted with success. It is rather a matter of great national concern that the industry should secure the greatest possible share of the world's steel trade, and give the utmost employment to the industrial workers of the country.

A further reflection, not altogether fanciful, is suggested by the amazing rate of increase in the world's consumption of steel. It is difficult to believe that a cheaper substitute for coal could ever be discovered for the manufacture of pig iron, and while we are assured that the coal resources of Great Britain may be expected to last for some hundreds of years, that is a comparatively short period when measured in terms of geological time. Even, however, if we need not concern ourselves with anxieties which lie in the dim and distant future, the cost both of coal and of ore must increase under the law of diminishing returns. Within the recollection of many of us, slack was regularly sold by collieries at 3*s.* per ton at the pit, and forty years ago the price of Cleveland pig iron was so low as 32*s.* per ton; yet in spite of improvements in technique, the real costs of both coal and pig iron have greatly increased. It would appear certain that this tendency must continue, and the real cost of steel in Great Britain, with the exhaustion of home supplies of ore and the inevitable increase in the cost of coal, will steadily rise. It is equally likely that certain other parts of the world more favourably situated in regard to ore and steel will enjoy an increasing economic advantage. Practical steel-makers will no doubt be better able to judge how far the cost of home supplies of ore will be affected during the next ten or twenty years, but taking a broad view, this reflection, so far as it is of substance, emphasises the importance of scientific organisation of the industry, both on the technical and commercial side.

The Iron and Steel Institute has done much in the past to assist in technical development, but still more intimate co-operation is now necessary. The vast world's consumption of iron and steel demands correspondingly large scale productions, the co-ordination of technical knowledge, and the most efficient application of every technical advance if a steel-producing nation is to hold its position in the race.

The manufacturers in the United States of America, and on the Continent, seemed to have realised this, and have set an example which might wisely be followed if the steel trade of Great Britain is to overcome the pressing difficulties of the next ten years and of the more remote period when we may gradually lose some of the national advantages which we at present enjoy.

Fossil Insects in Relation to Living Forms.

By Dr. R. J. TILLYARD, F.R.S., Cawthron Institute, Nelson, New Zealand.

WHEN Handlirsch completed his great work "Die Fossilen Insekten" in 1908, it was possible to take a wide survey of the problem of fossil insects. The outstanding feature of this was the great gap in our knowledge of Permian and Triassic forms. On one side it was seen that the present type of insect fauna could be traced back with little essential modification right to the English Lias, in which all the chief existing orders of insects are known except the Lepidoptera and Hymenoptera; on the other, there lay the very different Upper Carboniferous faunas of the Age of Giant Insects. The only connecting type common to both was the cockroaches, which are thus seen rightly to merit the name of aristocrats of the insect world, and, like other aristocracies, are in this democratic age a small and disappearing unit. Between these two were known only Permian cockroaches and a few Permian and Triassic types, not enough to enable us to trace a good connexion.

Three large and important insect faunas have since been opened up and carefully studied. Taken together, they almost completely fill the Permian-Triassic gap in the record, and show us in large measure the lines of evolution of the chief orders of insects. These beds are enumerated below.

(1) The Upper Triassic Beds of Ipswich, Queensland. —These were discovered many years ago by Mr. T. H. Simmonds of Brisbane, but more thoroughly explored by Mr. B. Dunstan, Chief Government Geologist of Queensland. From these about 250 specimens have been taken, yielding a complete fauna of about 120 species. Coleoptera are dominant, making 46 per cent. of the total fauna. Hemiptera (Fig. 5) come next in abundance, the sub-order Homoptera being much more strongly represented than the Heteroptera. Other orders present are the Odonata, Protorthoptera, Orthoptera (including a few Blattoidea or cockroaches), Mecoptera (scorpion-flies), Neuroptera (sub-order Planipennia or lacewings only), and a very interesting new order, Paratrichoptera, containing four-winged insects ancestral to the true Diptera. Of these last, four well-marked genera have been found.

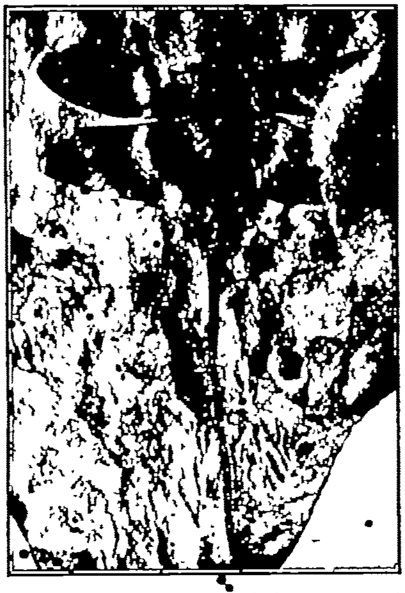

FIG. 1.—*Dunbaria fasciipennis* Till., the only known representative of the order Palæodictyoptera in the Lower Permian of Kansas. (Natural size.)

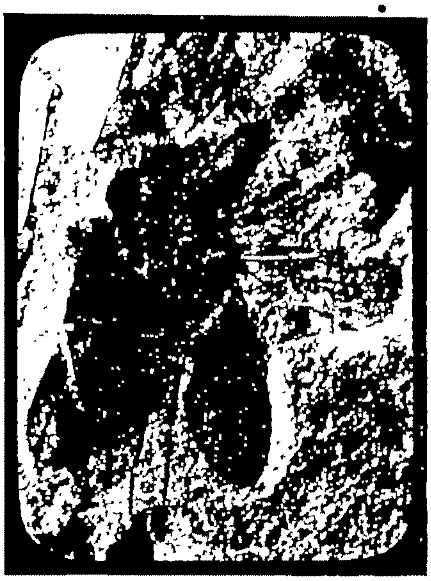

FIG. 2.—An undescribed species of Lemmatophora belonging to the new order Protoperlaria, ancestral to the stone-flies, and showing well-developed wing-flaps on the prothorax. (× 5.)

(2) The Upper Permian Beds of Belmont and Newcastle, N.S.W.—The discovery and working of these beds is due to Mr. John Mitchell, formerly head of the Newcastle Technical College, who in spite of his advanced age is still wielding his huge hammer on this hard, cherty rock, and, with the assistance of Mr. and Mrs. T. H. Pincombe of New Lambton, continues to add wonderful new types to the record. Nearly 200 specimens have been found and about fifty species so far described. These beds, originally classed by geologists as Permo-Carboniferous, have been shown to lie only about 300 feet below the bottom of the Trias, with no break hereabouts between Palæozoic and Mesozoic strata. The flora consists almost entirely of Glossopteris, and the associated insects form a highly specialised fauna of very few orders. Homoptera and Mecoptera are dominant; no Heteroptera have yet been found. With the numerous scorpion-fly remains there has been found one type allied to the anomalous recent American genus Merope, and, closely allied to that also, a type recognisable as the oldest known true lacewing (Neuroptera Planipennia). A new order, Paramecoptera, allied to the Mecoptera and evidently representing the common ancestors at that period of the three orders Diptera, Trichoptera and Lepidoptera, is found in these beds, there being two genera, Belmontia and Parabelmontia. A few true Coleoptera occur, together with a most remarkable series of larger forewings evidently allied to them and showing all gradations from a flattened, apically pointed tegmen with complete venation down

to half-formed elytra with the venation completely lost except in the anal region. These must be regarded as being remnants of the older order from which the true Coleoptera originated, and are called Protocoleoptera. As several quite distinct types occur, even in these small beds, these fossils give point to the remark frequently made by that wise old coleopterist the late Dr. D. Sharp, that the enormous order Coleoptera as we know it to-day must have had a polyphyletic origin.

(3) The Lower Permian Beds of Kansas.—A magnificent collection of fossil insects, totalling 2000 specimens, has recently been taken from this locality by the Yale University Expedition led by Dr. Carl Dunbar. The beds were originally discovered by Dr. Sellards of Yale, who also possesses an extensive collection, mostly unstudied. This fauna is the most important and best preserved of all known insect faunas, many of the specimens showing the colour-pattern and minutest hairs on veins and membrane of the wings. From its study we learn how the insects reacted to the change of climate between the Upper Carboniferous and Lower Permian. The advent of hot, arid conditions, with formation of salt lake areas, sounded the death-knell of the Age of Giant Insects, the only ones remaining in the Lower Permian being a few Protodonata and Protorthoptera and a single wonderfully preserved species of the old order Palæodictyoptera, *Dunbaria fasciipennis* Till. (Fig. 1).

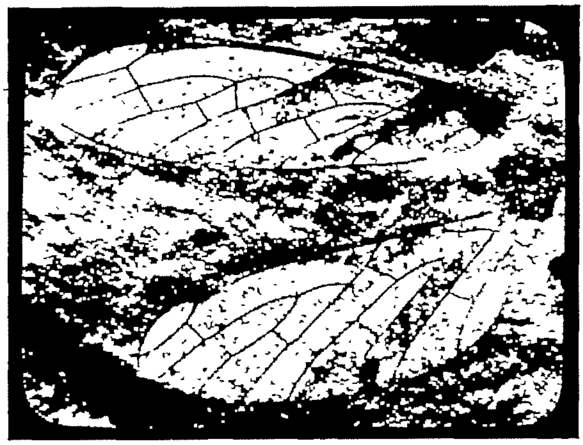

FIG. 3.—*Permohymen schucherti* Till., order Protohymenoptera, Lower Permian of Kansas. (×4)

The dominant type of insect was an aquatic type ancestral to the Perlaria or stone-flies of the present day. Some of these are preserved perfectly in every detail, and show a very unexpected character in the presence of well-formed wing-flaps with extensive venation, on the sides of the prothorax (Fig. 2). Mayflies (order Plectoptera) were also very abundant, but differed from those of the present day in having all four wings of about equal size and similar venation. Two genera of true dragonflies (order Odonata) are preserved, one showing almost a complete wing; their venation is much simpler than that of even the smallest damsel-fly of to-day, not even the closed quadrilateral cell being present. True scorpion-flies (order Mecoptera) were abundant, and all of very small size. Most of these were close allies of the existing Australian family Choristidæ, but one form was ancestral to the American genus Merope. The absence of any true lacewings, raphidians and sialids is most remarkable; the geological record of the Permian makes it almost certain that these are later specialisations from a much older mecopteroid stock. Incidentally, the scorpion-flies can be traced back to the Upper Carboniferous and are as old as any known winged insects; so that the problem of the origin of what is called holometaboly, or the formation of a true pupal or resting stage in insects, is bound up with the evolution of this little-known group of insects.

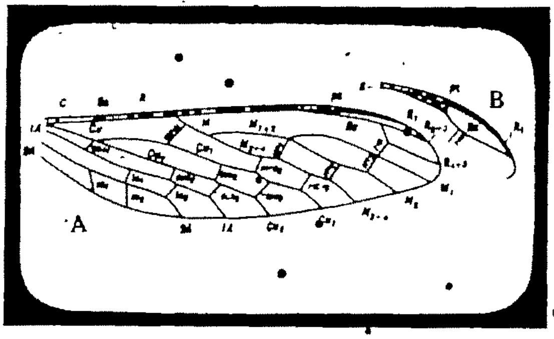

FIG. 4.—A. Diagrammatic representation of *Protohymen permianus* Till., order Protohymenoptera, forewing, from Lower Permian of Kansas. (×3.) B. Pterostigma of *Permohymen schucherti* Till. (×4)

Other orders recognisable in the Kansas beds are the Copeognatha or psocids, the Embiaria or web-spinners, and four types which can be definitely classed as Homoptera and are of exceptional interest in giving for the first time an accurate interpretation of the venation in that order. But the most wonderful find of all was a whole series of wings and some nearly complete insects belonging to the extinct order Protohymenoptera, containing the ancestors of the Hymenoptera in which fore and hind wings were of almost equal size and were not yet linked together in flight by hooklets. The astonishing simplicity of the venation in these types has quite upset the complex hypothetical explanations of Hymenopterous wing-venation due to MacGillivray and others, and at one stroke shows the true homologies of the veins and also makes it an easy matter for students to master the subject for systematic work. Of the three genera discovered, Protohymen (Fig. 4) stands right in the ancestral line of the recent order

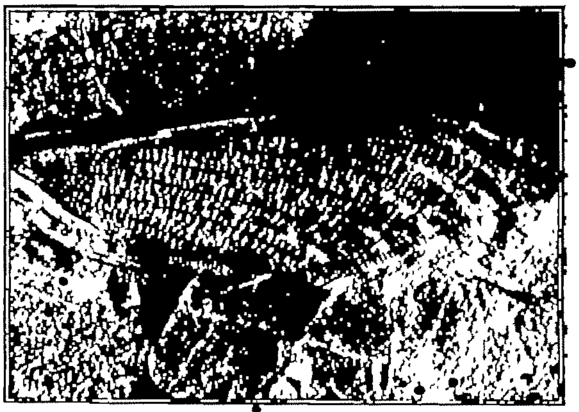

FIG. 5.—*Mesogereon superbum* Till., order Hemiptera, ancestral to the Cicadidæ, from Upper Trias of Ipswich. (×1½)

Hymenoptera, leading directly to the horntails and sawflies, while Permohymen (Fig. 3) and Asthenohymen must be regarded as specialised side branches.

The fossil evidence is now fairly strong that there were three distinct groups of holometabolous insects which evolved a pupal stage independently of one another early in the Permian period. These are (*a*) the Mecopteroid orders, namely, Mecoptera, Neuroptera, Paramecoptera, Paratrichoptera, Diptera, Trichoptera, Lepidoptera, and Siphonaptera; (*b*) the Hymenopteroid orders, Protohymenoptera and Hymenoptera; and (*c*) the Coleopteroid orders, Protocoleoptera, Coleoptera and their parasitic offshoot Strepsiptera. The only possible explanation of this appears to have been the marked change of climate which ushered in the Lower Permian. We must conceive that the pupal stage was a response to a new environment, the larva going underground and shortening the later nymphal instars into a single more complex change or metamorphosis.

In concluding this article, we must point out that the evidence as it stands at present points to a long history for winged insects before the Upper Carboniferous, though no fossils have yet been found in the Pterygota older than these. For the Apterygota, or primitive wingless insects (orders Thysanura, Protura and Collembola), an even longer geological history must be demanded, probably taking them back to the Lower Devonian. We know nothing as yet of the most primitive type of insect wing, whether it evolved from a gill or from a paranotal expansion, nor do we know anything at all about the original type of wing-venation except that it was probably a very simple one, not complex as in the highly specialised Upper Carboniferous groups. The problematical remains recently described as jaws and palpi of insects from the Rhynie Beds (Old Red Sandstone of Scotland) may well have belonged to Thysanura, but only careful study of definitely well preserved specimens could finally determine this point.

REFERENCES.—"Mesozoic Insects of Queensland," R. J. Tillyard, *Proceedings Linnean Soc. N.S.W.*, 1916–1924, 10 parts, various papers on fossils from the Belmont Beds by same author, *l.c.*, 1916–1926, Kansas Permian Insects, *American Journal of Science*, 9 parts, C. O. Dunbar and R. J. Tillyard, 1923–1926.

Obituary.

DR. J. T. BOTTOMLEY, F.R.S.

JAMES THOMSON BOTTOMLEY, who died in Glasgow on May 18, was born in Belfast on January 10, 1845. His father was William Bottomley, of Belfast, and his mother a sister of the late Lord Kelvin. He was educated at Queen's College, Belfast, and Trinity College, Dublin, where he had a distinguished career and was gold medallist at the degrees of B.A. and M.A. He started his scientific career by becoming assistant to Prof. Andrews at Belfast, afterwards a demonstrator of chemistry and physics in King's College, London, and in 1870 he came to the University of Glasgow to act as Arnott and Thomson demonstrator in the Department of Natural Philosophy, at the head of which was his uncle, Sir William Thomson. He held this position until 1899, when Lord Kelvin resigned from his professorship.

During these twenty-nine years Dr. Bottomley was continuously engaged in research work, and his researches covered a very extensive field, including liquefaction of gases, the use of liquid air for experiments on radiation at very low temperatures, the air thermometer, the bolometer, emissivity and conductivity of wires in vacuum, radiation from bright and black bodies, vacuum pumps, thermo-couples, modulus of elasticity, and the electrical properties of platinoid, etc. These papers were contributed mostly to the *Proceedings of the Royal Society*, and the Reports of the British Association. He published a book on theoretical mechanics in two parts, vol. 1 on dynamics, and vol. 2 on hydrostatics. But in this line he is best known as the author of "Four-Figure Mathematical Tables: Comprising Logarithmic and Trigonometric Tables, and Tables of Squares, Square Roots, and Reciprocals."

As time went on, Sir William Thomson delegated a good deal of the lecturing to students to Mr. Bottomley. He belonged to a type not uncommon in our universities, of distinguished scholars and amiable gentlemen, enthusiastic in their own department of study, and with every good desire in the world to help their students, but largely unable to impart their knowledge in the class-room. Uncle and nephew were both deficient in this respect, one being too advanced and abstruse for the average student, the other in being too ridiculously simple. He elaborated the obvious, sometimes painfully though unconsciously, wasting time striving to elucidate minor points which all understood. He did not seem able to state the salient points and pass on. Hence when he was getting on very well with his audience, often they would lose all patience with his meticulous niceties. When an emergency arose it appeared how difficult it is for the cloistered man of science to deal with a practical situation. Physics and psychology seemed to have no common ground. A sense of humour or power of repartee would heal the breach in a moment, but Dr. Bottomley was too serious for that and could not retaliate or change his mode of lecturing. Kelvin might bore the hilarious dawdlers quite as much, but they did not dare to take liberties with him.

As consulting engineer, Dr. Bottomley acted for the Scottish Asylums Board and for Nobels, Ltd. He had a regular electrical engineering consulting practice mostly concerned with lighting installations, such as Skibo Castle, Roxburgh Castle, etc. He joined the Institution of Electrical Engineers as an Associate in 1872 and was elected a member in 1889.

Dr. Bottomley became associated with the business of Kelvin, Bottomley and Baird when the firm was floated as a private limited company in 1900, and on the death of Lord Kelvin in 1907 he was appointed chairman, a position which he continued to fill until his death. In recognition of his distinction as a scientific worker and of his long and honourable connexion with the University of Glasgow, the degree of Doctor of Laws was conferred upon him in November 1904.

M. M.

MR. STEPHEN PAGET.

STEPHEN PAGET was born in Henrietta Street, Cavendish Square, London, in 1855, the fourth and youngest son of Sir James Paget, who was well known as the leading scientific surgeon of the mid-Victorian period. The tide was turning in the fortunes of his father when Stephen was born, for Sir James was writing that if he can afford that brougham his wife shall walk fewer miles in the week than she has often walked in the day. Stephen received his preliminary education at St. Marylebone and All Souls Grammar School in the Regent's Park just at the top of Baker Street. The school had been established by his maternal grandfather, the Rev. Henry North, domestic chaplain to the Duke of Kent, and received most of the doctors' sons in the neighbourhood. From this school he proceeded to Shrewsbury, where he had a good training in the classics, and from there he passed to Christ Church, Oxford, where his brother Frank was a senior student, graduating in 1878 after gaining second class honours in "Greats."

His eldest brother had been called to the Bar, the second and third had taken holy Orders, one afterwards becoming Bishop of Oxford, the other Bishop of Chester; Stephen decided to follow his father's profession. He entered as a student at St. Bartholomew's Hospital, obtained the F.R.C.S. Eng. in 1885 and was almost immediately elected assistant surgeon to the Metropolitan Hospital, whence he migrated to the West London Hospital. Here he became full surgeon until he determined to specialise, and was appointed surgeon to the Throat and Ear Department at the Middlesex Hospital. Ill-health overtook him and he was presently obliged to abandon all thought of practising his profession. He left London and settled at Limpsfield in Surrey, where he died on May 8.

Stephen Paget was ill-suited by health, temperament and education for the arduous life of a consulting surgeon, but he attempted it, failed, and by his failure was able to render services of the greatest value to physiology and pathology. Gentle in character, logical in thought, and before all things a lover of truth, he devoted the last eighteen years of his life to make known the truth about experiments upon animals and to show how the advance of medicine in every branch depends upon freedom of research. To this end he was instrumental in founding the Research Defence Society, of which he was the first secretary. The object of the Society was to fight against and expose the lies, half-truths and innuendoes of prejudiced anti-vivisectionists. Paget carried out the campaign with deadly effect against a host of fanatics and faddists. He wrote books, delivered lectures and published addresses, always courteously worded and without heat, which did much to allow an unscientific public to see the matters under discussion in their true proportion.

Paget wrote charmingly and in an easy style, which make it pleasant to read his many books. Biography perhaps interested him most. In "The Memoirs and Letters of Sir James Paget" he accomplished successfully the difficult task of a son writing the life of a distinguished father, whilst in the "Life of Sir Victor Horsley" he had to meet difficulties of an entirely different kind and he was equally successful. His lives of Ambroise Paré and John Hunter give delightful accounts of these great surgeons of a bygone age, whilst the "Confessio Medici" should be read and re-read by every student of medicine.

He married a daughter of Dr. Burd of Shrewsbury. To her and their two daughters medicine owes a debt of gratitude. Their loving care enabled him to devote all his time and energies to the great object of his life—the freedom of research.

MR. H. KIRKE SWANN.

HARRY KIRKE SWANN died on April 14 in New Barnet, near London, at the age of fifty-four years, after a short illness. He was chiefly known to ornithologists by his excellent books on the bibliography of British birds and his writings on the Accipitres or birds of prey. In 1916 appeared the "Bibliography of British Ornithology," a volume of 691 pages, which he wrote in collaboration with W. H. Mullens, and in 1919 appeared the "Geographical Bibliography of British Ornithology" in conjunction with W. H. Mullens and the Rev. F. C. R. Jourdain, in 1923 "A Bibliography of British Ornithology from the Earliest Times," by Kirke Swann alone, a chronological list of British birds, termed a supplement to the above-named bibliography.

His love of ornithology dates from Swann's boyhood; at twenty years of age he visited Nova Scotia and eastern Canada, and his zoological observations are embodied in an attractive little book, "Nature in Acadie," which appeared in 1895. In 1892 he founded in London the *Naturalist's Journal*, eventually continued by Mr. S. L. Mosley; the first two volumes were edited by him, and contained several articles by himself on British birds. Mr. Swann was always a busy man and could generally only devote his spare time to his beloved ornithology. He became a partner and later proprietor of the booksellers' firm of John Wheldon & Co., and in 1921 he joined with William Wesley & Son to form a company under the name of Wheldon & Wesley, Ltd., of which he was a director and very active member when he died. In 1913 appeared Swann's "Dictionary of English and Folk-Names of British Birds, with their History, Meaning, and First Usage; and the Folk-lore, Weather-lore, Legends, etc., relating to the More Familiar Species," a work containing a wonderful amount of information.

For a long time Mr. Swann took a special interest in the Accipitres or diurnal birds of prey, collected their eggs, and later on their skins. In 1920 there appeared his "Synoptical List of the Accipitres," followed in 1922 by a second revised edition under the title "A Synopsis of the Accipitres." These lists contained, in addition to the names, in accordance to the strictest priority, short diagnoses of the (unnecessarily numerous) genera, species and subspecies; considering the great variability of plumage, according to age, sex, and individual variation of most Accipitres, these diagnoses, though often useful to ornithologists, cannot suffice to determine the forms without more knowledge.

A few years ago Mr. Swann visited the United States, where he studied birds of prey in most of the larger museums, while in 1925 he made a collecting trip to Rumania and the Danube delta, with Mr. J. H. McNeile, and wrote an attractive little book, "Two Ornithologists on the Lower Danube."

In 1924 there appeared the first part of a large, ambitious work in quarto, called "A Monograph of the Birds of Prey," beautifully illustrated with coloured plates by Mr. H. Grönvold, of birds and eggs, and some photographs of nests, very well printed and well written. Possibly the Accipitres are not only the most attractive but also the most difficult group of birds for a systematist, and it is therefore not to be expected that Mr. Swann's work was in every case correct in the recognition and grouping of species and subspecies, but it is very regrettable that he could not finish it; so far only five parts have appeared, which is less than half the work.

SIR JAMES CANTLIE, K.B.E.

THE death on May 28 of Sir James Cantlie, at the age of seventy-five years, removes from our midst a man of originality and untiring energy, and a ready writer and speaker. In his early days he was demonstrator of anatomy and assistant surgeon and later surgeon to the Charing Cross Hospital, but most of his life work outside his practice, whether in London, Hongkong, or again in London, was devoted to teaching and pioneering in unexplored fields of medical education. A great believer in physical training and fresh air both for the young and the middle-aged for the maintenance of health, he first set out some of his views in 1885 in a remarkable paper entitled "The Degeneration of Londoners," which encountered a good deal of ridicule, but was remembered during the War when a large number of recruits for the army were placed in Class C.

Cantlie's knowledge of tropical medicine began in Egypt, when he was one of twelve young medical men sent out there to assist in combating the 1883 epidemic of cholera. His next experience was in Hongkong, where he became Dean of the Chinese Medical College, and in conjunction with Sir Patrick Manson carried on a large practice. In Hongkong he did some good work in helping to check the local outbreak of plague in 1894, though the measures were not successful in preventing the disease from being carried by infected ships to the ports of other countries. In close association with Yersin and Kitasato, he became conversant with the most recent knowledge concerning the disease at that time, which, when he returned to London two years later, was made use of by the London County Council, which employed him as its adviser on plague.

It was Cantlie who first started the idea of the necessity of the establishment of a School of Tropical Medicine in London. He was also a founder of the Society of Tropical Medicine and Hygiene, of which Sir Patrick Manson was the first chairman, and of which, when some years later it became the Royal Society of Tropical Medicine and Hygiene, Cantlie also became president. By his influence a tropical section was added to the annual meetings of the British Medical Association.

During the War, Sir James Cantlie, with the assistance of Lady Cantlie, performed very valuable services to the country by the training of men and women for Red Cross work.

MR. JOHN STUART.

IT is with much regret that we learn from the *British Journal of Photography* of May 7 that Mr. John Stuart died quite suddenly on April 28 in his ninetieth year. He had been chairman of the well-known firm of opticians, Ross Ltd., for many years, and was the proprietor of the *British Journal of Photography*. Mr. Stuart was born at Lossiemouth, and was attracted to photography in the very early days of the collodion process, and for a few years travelled in Spain, Portugal, and Italy making a large number of wet-plate negatives, many of which were used for publication. At this time Andrew Ross, who founded the firm, was dead, and his son, Thomas Ross, had succeeded him. Mr. Stuart joined the firm in 1870, and shortly after the death of Thomas Ross he married his widow. Under Mr. Stuart's direction the firm continued to expand, and all who are interested in optical matters will call to mind the name of Francis Wenham, who was a valued colleague. Mr. Stuart was the sole proprietor of the *British Journal of Photography* for more than forty years, and the editor states that his editorial and business staff were given a completely free hand, his influence, when exercised, tending towards the restriction of the publicity in the pages of the journal of the manufactures of Messrs. Ross Ltd.

IT is announced in the *Chemiker Zeitung* that Dr. Carl J. Lintner, emeritus professor of applied chemistry at the Technische Hochschule in Munich, died on April 9 in his seventy-first year. After graduating at Munich, Lintner turned his attention to the technology of agriculture and of brewing, and after some experience at the Experimental Station for Agricultural Chemistry in Halle and at the Institute for Brewing in Berlin, he returned to Munich in 1884 and began to collaborate there with Soxhlet. In 1896 he was appointed to the chair of applied chemistry, and from 1902 until 1914 he directed the Experimental Station for Brewing at Munich. His chief researches were upon enzyme action, especially in relation to brewing.

WE regret to announce the following deaths:

Sir Thomas Elliott, Bart., K.C.B., for twenty years secretary to the Board of Agriculture and afterwards Deputy Master of the Mint, on June 4, aged seventy-one years.

Prof. Nils Gustaf von Lagerheim, professor of botany and director of the Botanical Institute of the University of Stockholm, and corresponding member since 1892 of the Pharmaceutical Society.

Lieut.-General Sir William Leishman, K.C.B., F.R.S., Director-General of the Army Medical Service, on June 2, aged sixty years.

Dr. E. S. Reynolds, emeritus professor of clinical medicine in the University of Manchester, on May 22, aged sixty-five years.

Sir Stewart Stockman, Chief Veterinary Officer and Director of Veterinary Research at the Ministry of Agriculture and Fisheries, on June 2, aged fifty-six years.

Sir John Williams, Bart., G.C.V.O., emeritus professor of midwifery at University College, London, and president of the University College of Wales in 1913 and first president of the National Library of Wales, on May 24, aged eighty-five years.

News and Views.

An interesting feature of the proceedings at the anniversary meeting of the Linnean Society on May 27 was the presentation to the Society by Sir David Prain, on behalf of the subscribers, of a portrait of the general secretary, Dr. Benjamin Daydon Jackson. The portrait, by Mr. Ernest Moore, will commemorate Dr. Jackson's long and helpful association with the Society as an officer for a period of forty-six years—a period equal to one-third of the present life of the Society, which was founded in 1788. In 1880 Dr. Jackson, who had joined the Society in 1868, was elected one of the two honorary secretaries, succeeding Mr. Frederick Currey on the botanical side, and as such he continued to serve until 1902, when on the retirement of the assistant secretary, Mr J. E. F. Harting, he was appointed to the specially created post of general secretary As general secretary Dr. Jackson has for the past twenty-four years ably administered the Society's affairs, and his knowledge and experience have been invaluable to the successive presidents, secretaries, and councils.

Though he completed his eightieth year on April 3, Dr. Daydon Jackson looks back on an almost unbroken record of attendance at the fortnightly meetings of the Linnean Society during his forty-six years' official connexion with it. Even during his earlier period of service as botanical secretary, Dr. Jackson made the Society his headquarters, and his unrivalled knowledge of the Linnean collections has been at the service of fellows or visitors. Several generations of workers retain a grateful recollection of assistance given with equal cheerfulness to the eminent visitor from abroad or the young student at home. Reference was made to Dr. Jackson's encyclopædic work; the compilation of the "Index Kewensis" was necessarily centred at Kew, but the "Glossary of Botanical Terms" is a product of leisure moments at the Linnean Society, while his "Catalogue of the Linnean Herbarium" is intimately associated with the genius of the place His reputation as our authority on the work and collections of Linnæus was recognised at the Upsala celebrations in 1908 by the conferment of honorary degrees (Ph.D. and A.M) and a royal honour (R.N.O.). Dr. Jackson will continue his association with the Linnean Society as Curator of the Linnean Collections; in this capacity his services will still be available to workers, and it is hoped that he may find ample leisure for putting on record more of his great knowledge on Linnean matters.

There is some risk that expectations not likely to be justified are being founded on the recent discovery of fresh foot-and-mouth disease carcases as a source of outbreaks of foot-and-mouth disease. All those who have had to give serious consideration to the introduction of the disease from abroad in recent years have recognised importation of entire carcases or portions of carcases of animals slaughtered while affected with the disease as a clear possibility. In spite of this, very great quantities of chilled or frozen beef are introduced from foreign countries, including Argentina, in which foot-and-mouth disease constantly exists. There was reason, however, to think that that could not be a very fruitful source, because the virus of the disease would probably have lost its vitality in the carcases by the time they arrived here.

What makes fresh, unpreserved meat from Belgium and Holland particularly liable to start an outbreak of foot-and-mouth disease is that it may arrive in Great Britain within 24 or 48 hours after the animals are killed, and would then be certainly infective. That source can be effectively stopped, but it is much to be feared that it will not prevent the recurrence of outbreaks in Great Britain so long as the disease is highly prevalent in the adjacent countries of the continent. It is an important fact that Scotland has for a period of two years been free from foot-and-mouth disease, although it is known that during that period thousands of pigs' carcases have been imported from the continent. Besides, the disease was frequently introduced before the present practice of killing pigs and dispatching their fresh carcases immediately had been begun. The real risk lies in the fact that every person or thing that has been in contact with an animal affected with foot-and-mouth disease, or in a place where diseased animals have recently been kept, becomes capable of spreading the disease for a period that may last for some days at least, and may therefore cause an outbreak on arrival in Great Britain after the comparatively short journey from Belgium and Holland.

The address delivered to the Iron and Steel Institute by Sir Peter Rylands, which appears elsewhere in this issue, is an exceedingly illuminating one, and the chart showing the facts concerning the production of steel in different parts of the world is very striking. That the fraction of the world's production contributed by Great Britain is a diminishing one is, however, inevitable in view of the vast resources of easily accessible and chemically suitable ores and fuel possessed by the United States, and of the entry of other countries, having natural resources of an extensive kind, into the field of production. It would be of interest to see a similar chart in which the value of the steel produced was shown instead of the tonnage, when perhaps the British share would prove to be somewhat larger, on account of the position occupied by Great Britain as a producer of the highest classes of steel. Sir Peter Rylands rightly emphasises the importance of organisation to the industry, and attributes much of the success of American and German undertakings to the industrial organisation which has improved efficiency. On the scientific side, the British steel industry is already responsible for the conduct of a large volume of research work, but much more thorough co-operation is required in order that the fruits of research may be made available to the industry as a whole. Nowhere is the influence of purely scientific investigations on manufacture to be more clearly seen than in the steel industry, except perhaps in the electrical industry, in which the necessity of co-ordinating scientific knowledge with practice has been recognised to the fullest extent.

IN the course of his lecture on "Iron in Antiquity," delivered at the Royal Institution on June 3, Dr. J. Newton Friend referred to some interesting historical points as to the early use of metals. Native gold was known to man at a very early date and was highly prized on account of its intrinsic beauty and resistance to tarnish. Native copper and iron were also known in certain districts, but it was centuries later before man learned to reduce those metals from their ores. Iron was manufactured in the Near East at an early date. About 1300 B.C. the Hittites were beginning to use iron weapons for military purposes, and in a letter, thought to have been addressed to Rameses II. of Egypt, the Hittite king states that he is sending with the letter an iron dagger. The Romans, in late years, were skilled metallurgists. Virgil in his "Aeneid," written about 40 B.C., describes the smithy in full work, whilst Pliny, whose work on natural history appeared in A.D. 77, shows a considerable knowledge of iron ores and of the working of the metal. He appears also to have recorded the accidental formation of cast iron. An iron ring of Roman origin, probably the remains of a ferrule, was found recently at Uriconium, and appears to have been made by bending a strip of iron into the form of a ring and soldering the ends with some copper alloy Cast iron was known in Sussex about 1350, and soon became quite a common product. It was at first used exclusively for casting purposes, and in 1588 cast-iron guns were used, as well as bronze, by the Spaniards in their Armada. When, many years later, it was found that cast iron was the most suitable starting-point for the manufacture of iron and steel, the demand for it increased enormously. In 1800 the United Kingdom produced about ¼ million tons of pig iron, a quantity that had increased by 1918 to more than 10 million tons, but fell again to just over 6 million tons in 1925.

IT is possible that the activities of the Russians in the scientific exploration of northern Siberia may be strengthened by the co-operation of Norway. It is reported in the *Times* of June 3 that a conference has been held in the Soviet Legation at Oslo under the presidency of Dr. Nansen to consider the possibility of a joint Russian and Norwegian expedition to Yakutsk. The conference was attended by representatives of the University of Oslo, the Geographical Society, and the Foreign and Commercial Departments. The Russian Academy of Sciences was represented by Dr. Wittenberg. It was stated that there are at present sixty Russian men of science engaged in investigation in Yakutsk. This area is one of special interest, particularly to the anthropologist, on account of the light which investigation of its people may throw on ethnology and racial movement in Asia. Any investigation of the people and culture of Russian territory in Asia, however, and especially the investigation of its archæological remains, is of interest to a wide circle outside Russia. Any attempt, therefore, to strengthen Russian effort by interesting scientific workers of other countries in these investigations deserves careful and, where circumstances permit, sympathetic consideration.

MANY interesting facts relating to the early manufacture of glass were mentioned by Sir Flinders Petrie in the course of an address delivered at the annual meeting of the Society of Glass Technology held at University College, London, on June 1. Glass was produced in the Euphrates region and in northern Mesopotamia so long ago as 2500 B.C., but in Egypt all glass was imported until 1500 B.C. Fifty years after the introduction of Syrian workers into that country, however, it became one of the commonest of all objects. Glass beads, the most popular use of glass, were not then made from liquid glass but from glass paste, glass-blowing not having been introduced until the Christian era. Sir Flinders, in referring to the use of glass by the ancients for the purpose of weights, said that three glass weights of the same denomination which had been found proved on testing to agree within $\frac{1}{100}$ of a grain.

AN organisation similar to Science Service of Washington, for the purpose of supplying to the press readable and accurate knowledge of scientific progress, has been formed in Paris under the title of "Office d'Information scientifique et technique," at the instigation of M. le duc de Gramont. The board of control consists of J. L. Breton, director of the National Office of Scientific and Industrial Research and Inventions; Charles Fabry, professor at the Sorbonne; Armand de Gramont, president of the council of the Institute of Optics, Paul Janet, director of the École supérieure d'Électricité, Louis Lumière, of the Academy of Sciences; Louis Mangin, director of the Muséum national d'Histoire naturelle; Émile Picard, permanent secretary of the Academy of Sciences; Georges Roger, of the Academy of Medicine; Émile Roux, director of the Pasteur Institute. The director of the office is Lieut.-Col. J. Raibaud. The new institution will co-operate with Science Service of Washington in the exchange of news of scientific and industrial progress in France and the United States.

SOME interesting side-lights were thrown on Indian religious custom and medical practice in Sir J. C. Bose's lecture on the action of cobra venom on plants which was delivered before the Royal Society of Medicine on June 2. Sir J. C. Bose found by experiment on animals and plants that a moderate dose of cobra venom produced an arrest of the pulse before death. In Indian popular belief it was thought that when a person bitten by a snake exhibited signs of death, revival was possible. For this reason the body was not cremated but was placed on a raft and allowed to float down the river. *Shuchikayan*, of which an ingredient is a minute quantity of cobra venom, has been employed in Indian medicine for a thousand years when a patient is at the point of death from heart failure. It is believed to revive the failing activity of the heart.

He had found that minute doses of cobra venom also stimulate certain nervous activities of plants.

The annual conversazione of the Royal Society to which ladies are invited will be held in the Society's rooms on Wednesday, June 16, at 8.30 P.M.

The annual visitation of the National Physical Laboratory, Teddington, will take place on Tuesday, June 22.

Sir Dugald Clerk, K.B.E., well known for his work on the development of the internal combustion engine, has been elected Prime Warden of the Goldsmiths' Company.

The Ross Institute and Hospital for Tropical Diseases, Putney Heath, London, S.W. 15, will be opened by the Prince of Wales on July 15. The Government of Nigeria has given a sum of 1000*l.* to the Institute to mark its appreciation of the services rendered by Sir Ronald Ross to residents in the tropics by his researches into the causation of malarial fever.

At the forthcoming Oxford meeting of the British Association, August 4-11, Prof. A. S. Eddington will deliver an evening discourse upon the subject of "Stars and Atoms," and Prof. H. F. Osborn one on "Discoveries in the Gobi Desert by the American Museum Expedition" Public lectures will also be given in Oxford by Sir William Bragg, Sir Dugald Clerk, Capt. Eckersley, Prof. Julian Huxley, and Prof. P. F. Kendall.

It is announced in *Science* that the Willard Gibbs Medal of the Chicago section of the American Chemical Society has been awarded this year to Sir James Colquhoun Irvine, of the University of St. Andrews. The presentation will take place at the September meeting of the Chicago section of the Society, when Dr. Irvine will be attending the Philadelphia meeting of the American Chemical Society.

The following have been elected officers of the Manchester Literary and Philosophical Society for the ensuing year: *President*, Dr. H. Levinstein; *Vice-Presidents*, Prof. W. L. Bragg, Prof. H. B. Dixon, Mr. E. A. Eason, Dr. R. S. Willows; *Secretaries*, Mr. John Allan, Prof. W. H. Lang; *Treasurer*, Mr. R. H. Clayton; *Librarians*, Mr. C. L. Barnes, Dr. Wilfrid Robinson; *Curator*, Mr. W. W. Haldane Gee.

It is expected that the *Proceedings of the Optical Convention* will be published not later than August 1 next, and that they will therefore be available during the meeting of the British Association at Oxford. Owing to the large number of papers read at the Convention, and the consequent size of the Proceedings, it has been found necessary to increase the price, which is now fixed at 30*s.*, plus 9*d.* postage, instead of 25*s.* as previously announced. Orders should be addressed to the Secretary, The Optical Convention, 1926, 1 Lowther Gardens, Exhibition Road, London, S.W 7.

An exhibition of Tardenoisian and pygmy types of stone implements is being held (June 8-22) at the Royal Anthropological Institute, 52 Upper Bedford Place. The exhibits will form a very fairly representative collection of the microlithic industry such as, we understand, has not hitherto been gathered together. Specimens will be included from Northumberland, Yorkshire, East Anglia, the south of England, Cornwall, Somersetshire, and Wales, France, the Fayum, Mesopotamia, East Africa, India, and Sydney, N.S.W. The exhibition is open to all fellows of the Institute; those who are not members may obtain admission on presentation of a visiting-card.

According to a statement of the Berlin correspondent of the *Times* in the issue of June 3, a public Marriage Advice Bureau has been opened in Berlin under municipal auspices and with the support of the Prussian Minister of Social Welfare. It will conduct free medical examination of those about to marry. Advice will be given in those cases where hereditary or acquired disease seems to make postponement or renunciation of marriage advisable. The services of the Bureau are to be available also for those already married.

The Council of the Institution of Electrical Engineers has made the following award of premiums for papers read during the session 1925–26, or accepted for publication: The Institution Premium to Mr. L. C. Grant; Ayrton Premium to Mr. S. Mavor; Fahie Premium to Messrs. B. S. Cohen, A. J. Aldridge, and W. West; John Hopkinson Premium to Mr. S. Ferguson; Kelvin Premium to Mr. P. Dunsheath; Paris Premium to Mr. T. Carter; Extra Premiums to Prof. S. P. Smith, Messrs. J. L. Thompson and H. Walmsley, Dr. A. B. Wood; Wireless Premiums to Messrs. R. A. Watson-Watt and J. F. Herd, Mr. J. Hollingworth, Dr. R. L. Smith-Rose, and Mr. R. H. Barfield.

The Wellcome Historical Medical Museum, 54A Wigmore St., London, W.1, which has been temporarily closed for alteration and reorganisation, was partially re-opened on June 1. The work of reorganisation is still proceeding, and when completed the arrangement and classification of the collections will be systematised, and the objects made more accessible for inspection and study. The Museum is open to members of the medical profession and research workers generally from 9 A.M. to 6 P.M. on week days, except Saturdays, when the Museum is closed at 1 P.M.

At the recent annual meeting of the Iron and Steel Institute, the following awards of Carnegie scholarships were announced: Mr. F. H Arnfelt (Stockholm), 100*l.*, for research on iron aluminium alloys; Mr. V. N. Krivobok (Pittsburg), 100*l*, for a study of recrystallisation of metals after cold-working; Mr. A. G. Lobley and Mr. C. L. Betts (Great Britain), 100*l.*, for an investigation on the viscosity of iron and steel at high temperatures; Mr. A. R. Page, 100*l.*, to enable him to carry out research on the hardening and tempering of high-speed steels; Mr. Tibor Ver (Budapest), 100*l.*, to study the effect of alternating stresses on the structure and mechanical properties of metals; Mr. L. B. Pfeil (Swansea), 100*l.*, to continue his investigation on the growth and properties of single iron crystals; and Mr.

J. H. Partridge (Birmingham), who received 100*l.* in 1925 in aid of a research on the electrical and magnetic properties of cast iron, a further award of 50*l.* to enable him to continue the investigation.

THE Council of the Institution of Civil Engineers has made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1925–1926:—A Telford Gold Medal to Mr. O. L. Prowde (Makwar, Sudan); a Watt Gold Medal to Mr. H. R. Lupton (Leeds); Telford Premiums to Messrs. A. S. Angwin and T. Walmsley (London), V. Bayley (London), C. F. Bengough (Tewkesbury), A. Honeysett (London), J. N. Reeson (Melbourne, Victoria), and H A. Reed (Manchester); and a Crampton Prize to Colonel G. R. Hearn (Calcutta). The Council has also awarded the Coopers Hill War Memorial Prize for 1925 (consisting of a bronze medal, parchment certificate, and a sum of money) to Mr. E L. Everatt (Bombay). This prize was founded by the Coopers Hill Society in memory of Coopers Hill men who lost their lives in the War.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer and demonstrator in the department of Zoology of the East London College—The Registrar, East London College, Mile End Road, E 1 (June 16). An assistant lecturer in mathematics at King's College, Strand—The Secretary (June 23). Lecturers in physics and chemistry in the University of Durham—Head of the Department of Pure Science, South Road, Durham (June 26). An assistant for technical records work at the Building Research Station of the Department of Scientific and Industrial Research—The Director, Building Research Station, Garston, nr. Watford (June 26). A principal of the Pibwrylwyd Farm Institute of the Carmarthenshire Agricultural Committee—J. W. Nicholas, County Offices, Carmarthen (June 26). A lecturer in mathematics at University College, Southampton—The Registrar (June 29). An assistant lecturer in chemistry at the Liverpool Central Municipal Technical School—The Director of Education, 14 Sir Thomas Street, Liverpool (July 5). A keeper of the Department of Zoology of the National Museum of Wales—The Director, National Museum of Wales, Cardiff (July 9). A junior scientific assistant for Admiralty Research—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1. A woman resident lecturer in agricultural chemistry and botany at Studley College, Warwickshire—The Principal. An entomologist and research workers able to undertake independent inquiries on malaria, in the field or laboratory—The Secretary, Indian Research Fund Association, Simla, India. A teacher of mathematics and physics at the Wandsworth Technical Institute—The Principal.

Our Astronomical Column.

WOLF'S NOVA OF OCTOBER 1925.—Dr. W. H. Steavenson noted, at the meeting of the British Astronomical Association on May 26, that this object in Aquila increased slightly in brightness during the last two months of 1925, attaining mag. 8·7. Recent observations show that it is still of mag. 9, so that the decline is very slight. He suggested that the object is not a Nova but a normal star which has hitherto been hidden by a nebulous cloud from which it has just emerged. Its behaviour is so unusual that it deserves careful watching. Plates taken a few years ago show no trace of it, though they include stars of mag. 15.

COLOUR STUDIES OF VARIABLE STARS.—*Astr. Nach.* No. 5440 contains a study of certain variables by J. Hopmann; the colour index and bolometric magnitude were deduced at various stages of the light curve. Mira Ceti, when near minimum, became so red that it went beyond the limits of the comparison stars, and only estimates were possible. The last maximum of light occurred 1925, Dec. 7±2d, about 17 days later than the predicted date. The effective temperature of the star was then found to be 3470° as compared with 3780° at the maximum 11 months earlier. The star was, however, brighter last December than in the previous maximum: visual magnitude 3·20 compared with 3·61; bolometric magnitude 2·92 compared with 3·24. In the case of ζ Geminorum the range of bolometric magnitude is shown to be very much smaller than that of visual magnitude; in fact, the measures as they stand indicate an actual reversal of the curve, but this is not regarded as proved.

PARALLAX SURVEY OF KAPTEYN'S SELECTED AREAS.—Publications of Yerkes Observatory, vol. 4, part 4, contains a photographic determination of parallaxes in these areas (zone +45°) by Mr. Oliver J. Lee. The plan of wholesale photographic parallaxes was suggested by Kapteyn but has not met with general approval. The large scale of the 40-inch refractor is obviously an advantage in this research. Three hundred and ten photographic plates were used, all but nine being taken with a colour-filter; these nine were used mainly for proper motions. The parallax determinations are necessarily only relative. Ten or twenty stars were selected on each plate as standards: they were the faintest stars that had crisp, firm images (average magnitude 12·64), and a preliminary solution showed that they had very little proper motion, so they were presumably distant. The separate parallaxes and proper motions of 1041 stars are printed. The largest parallax is 0·113″ for a star of mag. 12·8 and proper motion 0·035″. About 3 per cent. of the stars have parallaxes so large as 0·06″. As one will expect, there are a large number of negative parallaxes. The effect of magnitude error is discussed and concluded to be small; a few of the plates were taken with a developed negative of the field used as a screen (a plan suggested by Kapteyn, which gives nearly equal magnitudes to all stars), but difficulties were found in working it.

The reduction of the relative parallaxes to absolute ones needs more absolute proper motions than are at present available in the region. Prof. Comstock, in a note included in the article, considers that the relative proper motions deduced need on the average a correction of about 1″ per century to reduce to the system of Boss.

Diagrams of the distribution of proper motions in the different areas are given; some of these, but not all, appear to conform to the two-drift configuration.

The author finally deduces the probable error of a proper motion as ±0·007″ and of a parallax as ±0·020″. He states that his results support the relative nearness of the galaxy in the region of R.A. 21″.

Research Items.

Teeth and Jaws of the Australian Aborigines —Anthropologists have long stood in need of data relating to the teeth and jaws of a primitive human race. This want has now been supplied by the publication, on the part of the University of Adelaide, of a thesis submitted to it by Dr. T. D. Campbell for the degree of Doctor of Dental Science ("Dentition and Palate of the Australian Aboriginal," The Hassell Press, 1925). Dr. Campbell's monograph is founded on a systematic examination of 630 dentitions collected from all regions of Australia, and representing every stage in the growth, eruption and wear of aboriginal teeth. The measurements of teeth and palate which are supplied by Dr. Campbell will prove of the utmost utility, and many of his observations are of high interest. In form and size of crown, in the number and arrangement of cusps, and in the development of roots, the teeth of the aborigines are "exceedingly primitive, probably more so than in any other living race and also than in some extinct races, such as Tasmanian and Neanderthal man." Large as are the dimensions of the molar teeth of Pithecanthropus (the Java man), Dr. Campbell met with examples in his series which outdid them. Particularly interesting to students of the teeth of fossil races of mankind are his observations on the filling up of the pulp cavity as a reaction to the wear of the crown—a reaction seldom seen in the teeth of civilised races. Campbell found that even amongst the aborigines the third molar teeth are the most variable, but whereas he had to examine nearly 200 skulls to find a single instance in which a third molar was absent, an English dentist would have to examine no more than five mouths to find a similar number. On the other hand, an English dentist would have to search 500 patients or more to find a fourth or supernumerary molar, whereas Dr. Campbell found seven or more instances in a similar number of Australian aborigines We have touched only on a few of the important and novel observations made by Dr. Campbell.

Neolithic Remains in Liguria.—In *Man* for May, Mrs J. W Crowfoot gives an account of some excavations carried out by her in the cave known as the Grotte de Bertrand in the Taggia Valley, near San Remo, in 1907–9. The cave proper is 33 ft long by about 12 ft with a bottle-neck entrance 8 ft 4 in. in length by 1 ft 7 in. in width and 1 ft 8 in. in height. It is 4 ft. high in the centre. The objects found included worked flints—a lunate arrow-point, and an arrow or javelin head, thick and roughly worked, with stem but no barbs—a needle-like pendant of bone, possibly made from a boar's tusk, six other bone pendants, also probably of boar's tusk, and five bone points, a number of shells of *Helix Nicaensis*, human skeletal remains of at least ten individuals, some showing primitive characters such as large teeth, heavy os calcis, perforation of the humerus, platycnemia, etc Nearly all the long bones and portions of the skulls were poked under the rock at the side of the cave and piled one upon top of the other, so that they could not be in the original position of interment Three hundred beads of five different types were found, including the winged type sometimes thought to be phallic Beads alternating grey and white were strung into a necklace identical with some in the museum at Toulouse. The human remains have been pronounced neolithic. Both Prof. Issel and Prof. Cartailhac, to whom the results were communicated, were of the opinion that the culture of the cave belonged to the late Neolithic period.

Fresh-water Amphipoda.—Hermann Spandl (*Sitzungsber Akad. der Wissensch*, Wien, Abt. I. Bd. 133, Heft 9, 1924) gives a systematic survey of the fresh-water amphipods and discusses the methods—active and passive migration—by which marine animals have entered fresh water. He refers in some detail to the amphipods of Lake Baikal, and concludes that many of the genera found there can be traced back to a small number of ancestral genera, the amphipod fauna of Lake Baikal does not represent a relict fauna but has arisen by progressive differentiation in the lake itself. In the Caspian Sea, however, the fauna can be divided into two parts, one part of marine origin and the other a fresh-water fauna, the genera in each category are given, and the relationships of this fauna with that of the Arctic Sea and of the Baltic are discussed A short account is given of the genera of amphipods found in subterranean waters and of the geographical distribution of fresh-water amphipods.

Morphology of Fishes.—Prof F. H Edgeworth (*Jour. Anat.*, vol. 60, pt iii.) gives an account of his reinvestigation of the development of certain of the branchial muscles in the Selachii. In 1911 the author concluded that the coraco-branchiales muscles were developed from the ventral ends of all the branchial muscle plates and the cucullaris muscle from the upper ends of the same plates. This conclusion was disputed by Allis Reinvestigation of the matter on new material has confirmed the author in his former conclusions In the same number of the *Journal of Anatomy*, Mr E. P. Allis contributes a paper on the homologies of the prechordal portion of the skull in the Holocephali, and concludes that the trabecular and polar cartilages of the skull are the pharyngeal elements of the mandibular and premandibular arches which have swung upwards and forwards, in connexion with the development of the mouth, into a position approximately parallel to the plane of the parachordals.

Resin Excretion in the Buds of *Alnus viridis*.—The development and micro-chemistry of the glandular hairs on the epidermis of the leaves and bud scales of Alnus have been studied by Friedrich Dormann (*Sitzungsber. Akad. der Wissensch.*, Wien, Abt I. Bd. 133, pp. 585–612, 1924). Many of these glandular hairs never share in the excretion of resin. Under examination these are found to be full of spherical droplets which, from their micro-chemical reactions, would appear to be complex terpenes. These contents, which seem similar to those in the glandular structures of Betula and Populus, are probably connected with resin formation. They occur, however, not only in the glandular hairs in Alnus, but also generally distributed in epidermal cells of the young leaves, so that the epidermis probably shares in resin secretion. Dormann concludes that the membrane of the cells shares in the work of resin excretion so that to this extent the expression 'resinogenous layer' used by Tschirch may be justified, but there is no reason for thinking that this part of the membrane is alone responsible for the complicated chemical changes involved in the production of resin

Campanula Mutants.—A large tetraploid mutation from *Campanula persicifolia* was exhibited horticulturally in 1916 under the name "Telham Beauty." It appears to be identical with a form recorded as coming from South Carolina in 1791, and must have arisen independently. It is self-fertile, while the species is self-sterile. Like similar tetraploids, Telham Beauty is stouter, has larger nuclei, and frequently more pores in the pollen grains. Its much larger flowers are, however, shallower in shape. It was crossed by Miss A. E. Gairdner (*Journal of Genetics*, vol. 16, No. 3) with *C. persicifolia* and with a dwarf form called *nitida* in which the flower has an almost superior ovary. Miss Gairdner finds that in the triploid F_1 (24 chromosomes) in diakinesis, univalent, bivalent and trivalent chromosomes occur. In the F_2 offspring various other chromosome numbers are obtained, one plant having 17, *i.e.* a single extra like many Œnotheras and Daturas, another being tetraploid (32 chromosomes). The hereditary behaviour of the latter indicates that the maternal chromosomes in the egg had been doubled. In the pollen formation of the tetraploid form, occasionally half of the heterotypic chromosomes split without separating, thus forming a tetraploid pollen nucleus.

DISCOVERY OF A DINOSAUR IN QUEENSLAND.—The remains of a large herbivorous dinosaur have been found in the Walloon series (Lower Jurassic) of Durham Downs in the Roma district of Queensland. They consist mainly of vertebræ with fragments of femur, tibia, fibula and pelvic bones, and are referred to a new genus, Rhœtosaurus, which is tentatively placed in the family Camarasauridæ of the Sauropoda. It is probable that Rhœtosaurus attained a length of more than 40 feet (H. A. Longman, *Mem. Queensland Museum*, 8, 3, 1926, p. 183, pls. 29-33).

AIR TEMPERATURE IN THE ARCTIC.—Six years in the Arctic have enabled Dr. H. U. Sverdrup to draw some valuable conclusions from his scientific observations with the Maud expedition. In an article in the *Scientific Monthly* for May on the results of the expedition, he points out that in winter the air temperature is always lower close to the ice than three hundred metres above it. The mean temperature at the ice is – 28·4° C., with a fall to about 100 metres, then a rapid rise to about 300 metres, and then a slower rise to – 20·3° C. at 1000 metres. On calm days the mean temperature at the surface averages about – 33° C. but corresponds with the mean at higher altitudes. The low surface temperatures are due to contact with the ice, which loses heat by radiation. Wind causes a mixing of the lower layers of the atmosphere on account of numerous eddies, and there is a decrease of temperature with altitude, but this clearly affects only the lower layers. At higher altitudes an inversion of temperature is the normal condition. Thus an explanation is offered of the phenomenon, previously noticed in polar regions, of a rise in temperature when the wind begins, independently of its direction. The minimum surface temperature is about – 45° C. because, though the ice loses heat by radiation, it is always gaining heat by conduction from the underlying sea, which retains a temperature of about – 1·7° C.

THE CONSTITUTION OF MALTOSE.—Irregularities in the results obtained by workers on the constitution of the polysaccharides caused considerable suspicion to fall on the formula given to maltose by Haworth and Leitch, and evidence has been published by J. C. Irvine and J. M. A. Black in the *Journal of the Chemical Society* for April 1926, which disproves Haworth's formula and substitutes two others between which no discrimination has yet been made. In the same issue of the journal a paper by C. J. A. Cooper, W. N. Haworth and S. Peat appears, confirming Irvine's work but admitting Irvine's priority. The constitution of maltose given by Haworth was based on the formation of 2:3:4 trimethyl glucose, but Irvine, by exact repetition of the experiments, has shown that this product is 2:3:6 trimethyl glucose. The revision of the structure of maltose involves the constitutional formulæ given to the other di-saccharides and poly-saccharides based on glucose.

THE CONDUCTIVITY OF PURE SODIUM HYDROXIDE SOLUTIONS.—The mobility of the hydroxyl ion has been determined by H. R. Raikes, A. F. Yorke and F. K. Ewart from conductivity measurements of sodium hydroxide in very pure water. Preparation of the carbonate-free hydroxide was carried out by electrolysis of sodium chloride solution, using a carbon anode and an iron cathode. The values, which appear in the *Journal of the Chemical Society* for March 1926, obtained from Washburn's value for the mobility of the sodium ion, are 173·8 and 144·3 at 18° and 10° C. respectively.

MAGNETIC PROPERTIES OF PERMALLOY.—From a separate copy of a paper on permalloy by Messrs. O. E. Buckley and L. W. McKeehan which appeared in the August 1925 issue of the *Physical Review*, we are able to supplement the information as to the magnetic properties of this alloy which was given in a note in our issue of January 9, p 65. Permalloy is the name given to a series of alloys of iron and nickel, containing from 45 per cent. to 80 per cent nickel. These alloys all possess high permeability for low fields and reach saturation at fields of less than 10 gauss. They have been tested in the form of wires 0.1 cm. in diameter, 60 cm. long in a solenoid nearly as long, by reversal of the field and measurement of the induction through a search coil wound over the middle of each wire and in series with a ballistic galvanometer. The 81 per cent. nickel permalloy reaches saturation at 4 gauss, when its intensity of magnetisation is a little more than 800, and at 1 gauss it has reached 700. The hysteresis loss per c.c. per cycle at induction 8300 is only 350 ergs, and is only half that amount for the permalloy with 78.5 per cent. nickel. When these wires are subjected to tension, saturation is reached within 5 per cent. for fields so low as 0·1 gauss and the hysteresis loss per c.c. per cycle reduced to 80 ergs.

TRANSMISSION FORMULA FOR RADIOTELEGRAPHY.—Mr. L. W. Austin has published in the *Journal of the Washington Academy of Sciences* for April 19 a preliminary note on proposed changes in the constants of the Austin-Cohen transmission formula used in radiotelegraphy. The formula has for the last twelve years been known to give satisfactory results for distances up to hundreds of kilometres and for rays of medium wave-length. At distances, however, of 6000 kilometres, the computed results are only about half those observed, and at 12,000 kilometres only about one-quarter of their true values. The author has made a close study of the numerous trans-Atlantic observations made by various observers during recent years. He finds it difficult to reconcile some of these observations In some cases the waves have passed over water all the way, in others they have passed over more land than water. The shortest great circle from Nauen to Washington is twenty-five per cent. land, but from India to the European stations nearly the whole path is over land. It is generally agreed that land attenuation is much greater than that over water. Nevertheless, by slightly altering the empirical factor of the formula and leaving the theoretical part due to Hertz alone, Mr. Austin obtains a formula which predicts with quite satisfactory accuracy the field intensities at distances ranging from 6000 to 12,000 kilometres. In a further paper he proposes to discuss the results the formula gives in all the available cases.

Visitation of the Royal Observatory, Greenwich.

THE annual visitation of the Royal Observatory, Greenwich, by the Board of Visitors, took place on Saturday, June 5, when the Astronomer Royal presented his report, which deals with the year ended on May 10, 1926. It commences with an allusion to the 250th anniversary of the foundation of the Observatory, which was celebrated last July; the King and Queen honoured the Observatory by their presence; the King presented a signed portrait of himself, which has been hung in the Octagon Room. Many foreign astronomers, who had come to England for the meeting of the International Astronomical Union at Cambridge, were also present.

The historic instruments in the Transit Circle Room were renovated for the occasion of the visitation, and it became possible to examine their beautiful graduation, which had been obscured for a long time. The standard sidereal clock is now kept in the cellar under the Octagon Room; this has been lined with cement, but is still damp; the clock being in an airtight case, this is not important.

The transit circle was used during the past year, as before, for observations of the sun, moon, planets and fundamental stars, also of stars brighter than mag. 8·0 in the zone from decl. +32° to +64°. The numbers of observations in right ascension and declination were about 10,000 each. The sun was observed on 136 days, the moon on 97. The corrections to Brown's "Tables of the Moon" for the years 1923, 1924, 1925 are: longitude +7·12″, +7·11″, +6·74″, latitude −0·55″, −0·76″, −0·84″. As regards the latitude, it will be remembered that Brown removed the constant term 1·00″ applied by Hansen; the observations indicate the need for a constant term of somewhat smaller size.

The division errors of the work transit circle were re-determined, the former values being confirmed. Observation is now beginning of 430 of the stars selected as comparison stars for Eros at the near approach in January 1931. Observations of fundamental stars with the altazimuth in the prime vertical have been continued. The results indicate that Boss's declinations between +11° and +50° need a nearly constant correction of +0·33″, agreeing closely with Raymond's result in *Astron. Journ.*, No. 857.

Work on double stars has been continued with the 28-inch equatorial; a catalogue of 400 stars has been prepared for press. 834 stellar parallax plates were taken with the Thompson 26-inch equatorial. 316 parallaxes have now been determined with this instrument, and a volume containing the first 266 of these has been published.

The 30-inch reflector is being used to study stellar temperatures of types B and A, by photographing spectra with a prism crossed by a grating. Stellar temperatures have also been compared with that of the positive pole of a carbon arc. A paper on the effective wave-lengths of stars between decl. +80° and +90° was published in *Mon. Not. Roy. Astron. Soc.* last November.

The astrographic equatorial is being used for the determination of proper motions, by repeating plates taken twenty-five to thirty years ago. In 700 square degrees, 194 stars have been found with centennial proper motion greater than 20″; 86 of these are fainter than the B.D. limit, 9·5 mag., 17 of the 86 have centennial proper motion greater than 30″.

The sun was photographed on 251 days, the series for the year being completed by the co-operating observatories. Solar activity was great from October until March, there being twelve naked-eye sunspot groups. The magnetic disturbances of January 26, February 23, March 5, were associated with two of these groups; that of April 14-15 occurred when a spot that had been visible to the naked eye in December, January, February was near the central meridian. Magnetic observations have been made at Greenwich for the last few years merely with the object of establishing the mean differences of the readings from those made at Abinger. The recent electrification of the New Cross—Lewisham railway line has rendered the Greenwich observations nearly valueless, and they will be discontinued when the still closer line through Greenwich and Maze Hill is electrified in July. The following table gives the magnetic elements at Greenwich in recent years, those for 1925 being provisional, also the mean difference Abinger *minus* Greenwich:

Year.	Dec. W.	Hor. Force. (c.g.s. units)	Vert. Force. (c.g.s. units)	Dip.
1921	13° 57·6′	0·18449	0·43218	66° 53·0′
1922	13 46·7	0·18447	0·43176	66 52·3
1923	13 35·1	0·18431	0·43137	66 51·9
1924	13 22·8	0·18426	0·43112	66 51·6
1925	13 10·0	0·18413	0·43081	66 51·5

Abinger *minus* Greenwich—

+12·8′	+0·00183	−0·00132	−16·2′

Magnetic disturbances at Abinger are, on the average, 2 per cent smaller than at Greenwich, while those at Stonyhurst are 20 per cent. greater.

Standardisation and certification of magnetometers has been carried out in recent years at Greenwich, but will in future be done at Abinger. A Schuster Smith magnetometer was brought into use at Abinger on May 1, and will be used to determine the horizontal force.

The following weather details refer to the year ended April 30, 1926. The mean temperature was 50·4°, which is 0·9° above the average. The extremes were 89·5° (July 22) and 16·0° (January 16). September was 3·4° below normal, February 5·8° above it. The mean daily movement of air was 275 miles, which is 9 below normal. The extremes were 741 miles (December 29) and 65 miles (October 6). The duration of bright sunshine was 1312 hours, or 29·5 per cent. of possible. The rainfall was 24·88 inches, which is 0·64 above the average. The wettest month was April, with 3·87 inches; the only wetter April was in 1878, with 4·31 inches. June and March were both absolute records for dryness, with 0·12 and 0·14 inches.

Wireless time signals from Paris (Eiffel Tower), Nauen, Bordeaux and Annapolis are recorded regularly on a syphon recorder. After applying all known corrections they are late on Greenwich by the following amounts respectively: 0·11 s., 0·05 s., 0·09 s., 0·06 s.

Mr. Davidson was absent from the Observatory from November 11 until April 1 for the observation of the total solar eclipse of January 14 in Sumatra. Very successful photographs were obtained. Mr G. Merton has continued his researches on cometary orbits; he also assists in the stellar parallax observations. Dr. W. H. Steavenson has made some observations of variable stars with the 28-inch equatorial. M M. Beljaieff and Dnieprovsky made a re-determination of the longitude Greenwich-Pulkovo. The reduction of the observations is not yet complete. Dr. Lundmark, of Upsala, assisted Mr. Melotte in drawing up a list of vacant areas in the sky, from the Franklin-Adams charts.

The short free-pendulum clock has performed very satisfactorily. The rate is increasing by 0·011 s. per day per month. A second clock of the same kind is now being erected.

The Italian Chemical Congress at Palermo and the Cannizzaro Centenary.

THE second Italian National Congress of pure and applied chemistry was held at Palermo, Sicily, on May 22-June 1, simultaneously with the centenary celebrations of the Sicilian chemist Stanislao Cannizzaro, who was born in Palermo in 1826. A monument was unveiled to his memory, and the Italian Chemical Society is publishing a book describing the main features of his life and work. Sir William Tilden, who delivered the Cannizzaro Memorial Lecture to the Chemical Society, summed up Cannizzaro's contributions to chemistry very broadly under the two following heads: "First, he laid down for all time the two principal methods by which atomic weights are determined, the one by reference to the molecular weights derived from an application of Avogadro's rule, and the other by an adoption of the principle discovered by Dulong and Petit as to the general relation of atomic weight to specific heat among the solid elements, and he showed that these two methods when applicable to the same case lead to the same results. Secondly, he placed inorganic chemistry in a new light by applying to inorganic compounds the same principles which had been applied to organic compounds, and thus finally disposed of the superstition which had hovered so long in the minds of chemists that organic chemistry was subject to laws different from those prevailing among mineral substances."

No better place could have been found than Palermo for the centenary celebrations. Not only was Cannizzaro born there, but also for ten years he held the chair of organic and inorganic chemistry at that University, refusing chairs at both Pisa and Naples in order to take it. He only left it to take the highest post in chemistry that Italy could bestow, the chair at Rome. During the Sicilian revolution in 1847 he left his studies under Piria to serve as an artillery officer in the Sicilian army, and handled his battery so well at Messina that he was sent to Taormina to oppose the Neapolitan troops. The final defeat of the Sicilian troops in 1849 made him a fugitive, and he finally made his way to Chevreul's laboratory in Paris, where he stayed until recalled to Italy in 1851 as professor at the National School at Alessandria, going four years later to Genoa, whence he published in 1858 his famous "Sunto di un Corso di Filosofia Chimica." In 1860 he again took arms, this time under Garibaldi, but without seeing any active warfare. From 1861 until 1871 he held the chair at Palermo, and from there he went to Rome, being at the same time made a Senator of the kingdom. From then until his death, in 1910, his life was full and varied, and honours, both civil and scientific, were showered on him.

Besides the reading of numerous papers in various branches of chemistry, an interesting programme of sight-seeing in Sicily had been arranged for those who attended the Congress, and a wide field of historical and scientific interest was covered, amid some of the most magnificent scenery of southern Europe. The itinerary included a visit to Mondello, near Palermo, to inspect the works of the Societa Gen. Elettrica della Sicilia on May 25; to the Arenella Chemical Works on May 26, to the sulphur mines of Cozzi Disi, near Girgenti, and the Campfranco works of the Montecatini firm on May 28; to the asphalt deposits of Ragusa on May 29; to the Magnisi salt mines on May 30; to the sulphur mines and other places of interest near Catania—including Mt. Etna—on May 31, and finally to Messina on June 1.

University and Educational Intelligence.

BIRMINGHAM.—The following gifts have recently been announced: 50*l*. towards the expenses of the new Fuel Treatment Laboratory, by the Bromford Tube Co., Ltd.; mounted illustrations for use in the Botanical Department, by Mrs Wilson King; pair of telephones, shown at the Paris Exhibition in 1878, by Mr. J. C. Vaudrey, two alternators, for use in the Electrical Engineering Laboratory, by Mr W. F. Higgs.

CAMBRIDGE.—The late Dr. J. E. Bles has left to the University an immediate gift of his scientific apparatus and books and the contents of his private library and (subject to his wife's life interest) the entire residue of his estate. The latter benefaction is expressly for the purpose of founding a professorship, preferably in animal embryology.

A readership in ethnology is being established, the present post, a personal appointment for Dr A. C. Haddon, terminating on his retirement at the end of the present term.

LEEDS.—Applications are invited, until June 19, for the open fellowship, value 200*l*., of the Institution of Gas Engineers for the prosecution of post-graduate research in gas chemistry. Particulars are obtainable from the Registrar of the University.

DR E. A. OWEN, head of the Radiology Division of the National Physical Laboratory, Teddington, has been appointed to the chair of physics at the University College of North Wales, Bangor.

LEPLAY HOUSE August Vacation Courses include this year visits to Dinant and the valley of the Meuse, Rochefort and the Belgian Ardennes, Irish Lake District; and Bagnères-de-Bigorre, in the High Pyrenees. These visits are open to all students and others interested in the study of geography, geology, plant life, history, and sociology. Particulars can be obtained from Miss Margaret E. Tatton, Leplay House, 65 Belgrave Road, Westminster, S.W. 1.

THE annual report on the work of the University of London presented on May 12 by the Principal Officer, Sir Cooper Perry, who is about to retire, shows a slight decrease, from 7603 to 7577, in the total number of admissions and an increase from 31,623 to 32,353 in the number of candidates for all examinations. Of 3819 candidates for degrees, 2301 were internal and 1518 were external students, the number of internal students increased from 9002 to 9323. Specially noteworthy among the private benefactions mentioned in the report is the gift of 20,000*l*. by Sir Daniel Stevenson for the establishment of a part-time chair of international history and for the development of a department dealing with that subject. Other private benefactions to the University amounted to about 55,000*l*. and the London School of Economics received more than 30,000*l*. from the Laura Spelman Rockefeller trustees. The progress of the movement for broadening the bases of university education is exemplified by the new regulations adding music and law as optional subjects to various examinations. The holiday course for foreigners held last summer attracted more applications for admission than any of its seventeen predecessors, and more than 200 had to be refused, which seems a pity. Those admitted numbered 256, representing 22 nationalities. The courses in journalism are increasingly sought after; the number of students increased from 53 in 1924–25 to 74 in 1925–26. The scheme of advisory service for external students introduced experimentally last year proved effective.

Contemporary Birthdays.

June 12, 1851.	Sir Oliver Joseph Lodge, F.R.S.
June 12, 1858.	Sir H. H. Johnston, G.C.M.G., K.C.B.
June 13, 1854.	Hon. Sir Charles Algernon Parsons, K.C.B., F.R.S.
June 13, 1870.	M. Jules Bordet, For. Mem. R.S.
June 14, 1857.	Prof. John Edward Marr, F.R.S.
June 15, 1851.	Prof. E. H. Griffiths, F.R.S.
June 17, 1860.	Prof. William Henry Perkin, F.R.S.
June 18, 1858.	Prof. A. R. Forsyth, F.R.S.

Sir Oliver Lodge, born at Penkhull, Staffordshire, was educated at Newport (Salop) Grammar School, and University College, London. From 1900 to 1919 he was principal of the University of Birmingham. In 1898 he was awarded the Royal Society's Rumford medal, and it was remarked then that in dealing with Hertz's discovery of electro-magnetic radiation it was requisite to recall the work done previously, or simultaneously, by Lodge on the surging or oscillatory character of the transmission of electric discharges along wires. Sir Oliver was president of the Society for Psychical Research, 1901–4.

Sir Charles Parsons, inventor of the steam turbine, a son of the third Earl of Rosse (president of the Royal Society from 1848 until 1854), was born in London. Following private tuition, he graduated at St John's College, Cambridge. An apprentice for a number of years in Armstrong's Elswick Works, he afterwards served on the experimental staff of Messrs. Kitson and Co., Leeds, leaving to enter into partnership (lasting from 1884 to 1889) with Messrs Clarke, Chapman, and Co., Gateshead Sir Charles has been for many years actively concerned with various electrical and engineering undertakings; among these should be mentioned the onerous post of chairman (since 1908) of the Parsons Marine Steam Turbine Co., Ltd. Awarded, in 1902, the Royal Society's Rumford medal for his success in the application of the steam turbine to industrial purposes, and to navigational uses, Sir Charles received, later, in similar recognition, the Albert medal of the Royal Society of Arts. Sir Charles was president of the British Association at the Bournemouth meeting, held in 1919. Guided by a native discretionary sense, many worthy scientific schemes have received encouragement from time to time through his beneficence.

M. Jules Bordet, foreign member of the Royal Society, was born at Soignies, Belgium. Attached to the Pasteur Institute, Paris, from 1894 to 1901, he left to become director of the Pasteur Institute, Brussels, whilst from 1907 he has been professor of bacteriology in the university of Brussels Prof. Bordet was Nobel laureate in 1919 in the physiology and medicine section.

Prof. Perkin, born at Sudbury, was educated at the City of London School and various foreign universities Awarded the Royal Society's Davy medal in 1904, for his "masterly and fruitful researches in the domain of synthetic organic chemistry," this was followed last year by the distinction of a Royal medal, in recognition of his more recent contributions to chemical science.

Prof. Forsyth is a native of Glasgow He was educated at Liverpool College and Trinity College, Cambridge, where he was senior wrangler and first Smith's prizeman Formerly Sadleirian professor of pure mathematics in the University of Cambridge, he was, until recently, chief professor of mathematics in the Imperial College of Science and Technology, South Kensington. Prof. Forsyth is a Royal medallist of the Royal Society

Societies and Academies.

London

Royal Society, June 3.—**A. E. H. Tutton**: The alkali perchlorates, and a new principle concerning the measurement of space-lattice cells. The crystallographic character and optical properties of the perchlorates of potassium, rubidium, cæsium and ammonium have been investigated. The crystal angles and goniometrical constants are progressive in the order of the atomic numbers of the alkali metals, the average change for the replacement of potassium by cæsium being double as much as occurs when rubidium replaces potassium Optical properties and the sizes, both relative and absolute, of the unit-cells of the space-lattice also show the progression with atomic number of alkali metal very clearly. The absolute dimensions of the cells have been found by a new principle. In an isomorphous series based on similar structure, if one member crystallises well and can be thoroughly investigated by X-rays and the cell dimensions determined in Ångström units, the cell dimensions of all the other members can be calculated. The case of the perchlorates and barytes group affords the first, and an excellent, example The structure and cell-dimensions of barytes are known with certitude. The cell-dimensions of the minute crystals of the isomorphous perchlorates of the alkalies have been calculated from their topic axial ratios and the barytes data In one case a critical test has been possible, that of potassium perchlorate, X-ray analysis of which has been just adequate to afford the cell-dimensions; and these have proved to be practically identical with those calculated on the new principle.—**T. E. Stanton**: On the flow of gases at high speeds. An experimental investigation was undertaken on the nature of the flow of a gas through orifices and nozzles at speeds in the neighbourhood of and exceeding the velocity of sound The prediction of Osborne Reynolds that a minimum section of the jet would exist at that point in it at which the theoretical critical pressure p_c obtains has been fully verified. The magnitude of the minimum section and its position relative to the throat of the orifice or nozzle depend on the value of the receiver pressure. The conditions for dynamical similarity in jets from geometrically similar nozzles and orifices at speeds above the velocity of sound depend on the viscosity of the gas and not solely on the ratio of the speed to that of sound. A reliable method of measuring the velocity at a point in a jet moving at speeds above the velocity of sound has been developed from the relation, determined by the late Lord Rayleigh, between the pressure in front of a fixed obstacle in the jet and the pressure of the jet The flow throughout the jet except in the neighbourhood of the walls of the nozzle is sensibly adiabatic.—**G. I. Taylor** and **W. S. Farran**: The distortion of crystals of aluminium under compression (Pt. I.) A disc cut from a crystal of aluminium can be compressed in such a way that the distortion is uniform throughout the material In these circumstances the distortion is of the same nature as that which occurs when a uniform single-crystal bar of aluminium is stretched, *i.e.* it is due to slipping parallel to a certain crystal plane and in a certain crystallographic direction The sign of the component of force normal to the plane of slip appears to make no difference to the nature of the slip.—**E. V. Appleton**, **R. A. Watson Watt** and **J. F. Herd**. On the nature of atmospherics (II.) The method now involves the use of a cathode ray oscillograph with a time-base, which is both uniform in scale and unambiguous as to time-sense Statistical analyses of approximately 8000 individual drawings of atmospheric wave forms show that sensibly aperiodic discharges were three times as numerous as were quasiperiodics; predominantly positive discharges were one and a half times as numerous as were negatives. The mean quasiperiodic had a peak field strength of 0·159 *V/m*, the aperiodic 0·075 *V/m*. The negative discharges of both types were stronger by 20 per cent. to 30 per cent. than the positives. The mean quasiperiodic had a duration 3125 μs, 30 per cent. greater than that of the mean aperiodic. The most frequently occurring form of atmospheric was a symmetrical rounded positive aperiodic, forming 14 per cent. of the whole distribution. The most frequent quasiperiodic, forming 7½ per cent. of the distribution, had a peaked positive half-cycle followed by a single rounded negative half-cycle. The experiments on atmospheric waveforms have been supplemented by observations on the net changes of the earth's electric field, resulting from lightning discharges. These observations at Aldershot, Cambridge, Helwan and Khartoum show that, at distances greater than 50 km. from the discharge channel, negative changes of field are at least 1·6 times as frequent as are positive changes. Since the field-changes at such distances may be taken as indicative of the sign of the thundercloud moment destroyed by the flash, it is concluded that lightning flashes resulting in the destruction of positive electric moments are at least 1·6 times as frequent as are those of opposite character.—C. H. **Lees**: On the determination of the specific heats of gases at constant pressure and at constant volume, and their ratio by adiabatic expansion. The specific heats of gases or the ratio of them cannot be determined to an accuracy of 1 part in 2000 or in 15,000 respectively unless either the temperature is determined to less than 0·01° C. or the adiabatic fall of temperature is increased above the 6° or 7° C. now used. If the latter course is adopted, the effect of the change of specific heat with temperature may be rendered negligible by taking the result calculated from the observations holding at the geometric mean of the initial and final temperatures of the expansion. Neglect of the deviation of the gas used from the perfect gas equation $pv = RT$ introduces an error of 1 part in 2000 in the value of the specific heat, calculated from observations at atmospheric temperatures with the usual expansion, if the deviation is only about one-fifteenth of that of carbon dioxide. The choice of characteristic equation for the gas introduces differences of the order 1 part in 400 in the value of the ratio of the specific heats calculated.—T. G. **Room**: A general configuration in space of any number of dimensions analogous to the double-six of lines in ordinary space. In space of three dimensions, it is possible to have two sixes of lines, of which every line of one six meets all but one line of the other six. Thirty-six such double sixes can be chosen from the lines existing on a general cubic surface. In space of n dimensions it is possible to have a set of $\frac{1}{2}n(n+1)$ lines, and a set of the same number of $(n-2)$ folds, corresponding to the lines in a like manner, as regards their intersections. It is now shown that in space of n dimensions it is possible, for any value of r less than n, to have a number of r-folds, and an equal number of $(n-r-1)$ folds, with the like property of intersection of corresponding elements. In the case of the double six of lines in ordinary space, there exists a quadric in regard to which the lines of one six are the polars of the lines of the other six. It is now shown that, except for the case when one set of elements consists of points, there exists no such reciprocating quadric in space of more than three dimensions. The existence of such a double set of corresponding elements is, however, not limited to the case when these are of dual character, such as a point and an $(n-1)$-fold, a line and an $(n-2)$-fold, and so on. In this paper a much more general theorem, establishing a double figure of elements with a like property of intersection, is obtained.—C. N. **Hinshelwood** and W. K. **Hutchison**: A comparison between unimolecular and bimolecular gaseous reactions. The thermal decomposition of gaseous acetaldehyde. The thermal decomposition of acetaldehyde in the gaseous state has been investigated over the temperature range 430°-592° C. The reaction is bimolecular, and under the conditions of the experiments, practically entirely homogeneous. The rate of reaction can be calculated from the equation

$$k = 5\cdot5 \times 10^{10}\sqrt{T}\,.\,e^{-45,500/RT},$$

k being expressed in gram molecules per litre per second. The contrast between this reaction and the chemically very similar decomposition of acetone is illuminating. The latter reaction, being unimolecular, is not necessarily dependent on collisions, and the number of molecules transformed in unit time is 10^{5} times greater than the number which could receive the heat of activation from collisions. In the bimolecular decomposition of acetaldehyde there is almost the exact relation between heat of activation, number of collisions, and rate of reaction, which the simplest theory predicts.—P. A. M. **Dirac**: (1) The elimination of the nodes in quantum mechanics. (2) Relativity quantum mechanics, with an application to Compton scattering. The quantum mechanics of Heisenberg are generalised to agree with relativity kinematics and dynamics. Each step in the generalisation is obtained by putting its classical analogue into a form that can be interpreted immediately on the quantum theory. The relativity quantum theory thus obtained requires that an atomic system shall recoil when it emits radiation in agreement with the light-quantum theory. Applied to the scattering of radiation by a free electron, the frequency of the scattered radiation and the recoil momentum of the electron are the same as those given by Compton's light-quantum theory, although the present theory is entirely a wave theory. The intensity of the scattered radiation is equal to its classical value reduced by the cube of the ratio by which the frequency is reduced, which is in good agreement with experiment.—A. **Fage** and L. J. **Jones**: On the drag of an aerofoil for two-dimensional flow. Prof. G. I. Taylor has shown, from considerations of momentum, that it should be possible to determine the drag of an aerofoil from the integral of the total-head losses in the wake at some distance behind the aerofoil. For two-dimensional flow this method gives satisfactory experimental results. In the neighbourhood of minimum drag the normal components of pressure around the aerofoil account for about 80 per cent. of the total drag; the contribution of the surface tractions is therefore about 20 per cent. The Prandtl method of predicting two-dimensional drag from force measurements on an aerofoil of finite span (span = 6 chords) is fairly trustworthy. Observations of pressure and velocity taken at some distance behind the aerofoil indicate that most of the total-head losses in the wake arise from the slowing-up of the air, and that the pressure does not differ appreciably from that in the surrounding stream.—F. W. **Carter**: On the action of a locomotive driving wheel. The relation between the tractive effort of a locomotive driving wheel and the surface strains in wheel and rail at points just ahead of the area of contact—a matter affecting the running qualities of the locomotive—is investigated. In general, the area of contact between wheel and rail is divisible into two portions, characterised by distinct conditions, namely, a certain initial portion in which there is no slipping between contiguous wheel and rail surfaces, and a final portion in which the surfaces slip as the strains tend towards the values existing behind the contact. Treating the problem as two-dimensional, the conditions to be satisfied in the two portions of the contact area are indicated, and a solution obtained.

Geological Society, May 19.—Jane **Longstaff** (*née* **Donald**): A revision of the British Carboniferous Murchisoniidæ; with notes on their distribution, and descriptions of some new species. Six new species and one variety are figured and described, as well as five species recorded by L. G. De Koninck in Belgium, which, with one exception, had not been previously noted in the British Isles. Altogether fifty-two species and one variety have been recorded, which are referable to five other genera and sub-genera besides Murchisonia *sensu stricto*, the greater number belong to the genus Hypergonia. Seventeen species are common to Belgium, all of which are Viséan except three, two being Tournaisian and one Waulsortian. Scotland has the most species; and so far twenty appear to be peculiar to that country, nine to England and one to Ireland. The greater number of British species are of Dibunophyllum age, only eight being from lower and two from higher zones.—T. N. **George**: The Carboniferous Limestone (Avonian) succession of a portion of the North Crop of the South Wales Coalfield. A description is given of the lithological and faunal succession of the Avonian along some thirty miles of the North Crop between Kidwelly and Penwyllt (Tawe Valley). The Main Limestone is much attenuated, when compared with other areas, being about 500 to 600 feet thick. The Middle Dibunophyllum zone is represented by two facies, deposited in more or less separate areas. That seen near the Kidwelly district consists of standard limestones yielding a normal fauna, and is comparable with beds of the same horizon in Gower, Pembrokeshire, Bristol, etc. The other consists of impure sandy and cherty limestones, with some calcite-mudstones, and a fauna chiefly composed of molluscs and Productids. As this facies is traced eastwards towards Llandebie it becomes more normal. It is evident that throughout Avonian times the area was subject to periodic earth-movements.

PARIS.

Academy of Sciences, May 3.—S. **Winogradsky**: The diagnosis of the aptitude of the soil for fixing nitrogen. Two factors intervene in this diagnosis: the number of nitrifying organisms present and the fertility of the soil as measured by the growth of these organisms. The method of spontaneous cultures measures the latter, and the silico-gel plate method measures the concentration of the organisms. Full details of the method proposed for applying these two tests is given.—Jean **Tilho**: An aggravation of the danger of capture by the Niger of the principal affluents of the Tchad. It is known that the existence of Lake Tchad is threatened by the possibility of the capture of the Logone-Chari hydrographic system, its principal tributary, by the Benone, which flows into the Niger. This danger has been increased by the construction of a canal between Ham and Pogo. It is pointed out that if the Tchad area became dry, some 200,000 square kilometres of soil now producing cotton, maize, tobacco, etc., would become sterile. Precautionary measures for preventing this disaster are suggested.—Enea **Bortolotti**: The envelopment of surfaces and the transport of directions along a curve.—André **Weil**: Surfaces with negative curvature.—**Tzitzeica**: A new class of congruences.—Paul **Mentré**: Surfaces of which the network of projective deformation is a conjugated network of Kœnigs.—J. **Ser**: An expression of the function $\xi(s)$ of Riemann.—B. **Finzi**: Energy proof of the paradox of d'Alembert in viscous liquids.—R. **Moineau**: Aeroplane with turning wing system.—A. **Zimmern**: A new method of production of herepathite. A method of preparing large crystals of iodoquinine sulphate.—A. **Dauvillier**: Extension of the Röntgen ray spectrum towards the ultra-violet; the *K* spectrum of carbon. The grating was composed of a preparation of melissic acid on lead, which was found to give pure spectra with a reticular distance of 87 Å.U. Difficulties were met with in separating the soft X-rays from the light diffused by the anode and reflected from the grating, and details are given of the manner in which these difficulties were overcome. With a graphite cathode there was obtained an intense line 45·3 Å.U.: this is the $K\alpha_1$ line of carbon and constitutes the unique *K* radiation of this element.—P. **Lebeau** and P. **Marmasse**: The estimation of small quantities of hydrogen in gaseous mixtures. The gas mixture is passed over a silica gel maintained at −190° C., which has been found to retain nitrogen, methane, carbon monoxide, oxygen and argon. The accuracy of the separation is shown by analyses of synthetic gas mixtures, the absence of hydrogen in two natural gases (marsh gas from a pool and gas from borings at Pechelbronn) has been proved by this method.—A. **Travers**: The oxidation of manganese to permanganic acid and its consequences in the application to the estimation of manganese.—Marcel **Guillot**: Researches on the complex salts arising from the action of α-picoline on the alkaline iridohexachlorides.—Mme. Ida **Vaillant-Couturier-Treat**: Note on the marine Permian of Madagascar.—C. **Dauzère**: The formation of the 'atmospheric vase' and of the 'sea of clouds'.—E. **Miège**: The appearance of *Triticum durum* in the descendants of hybrids of two *Triticum vulgare*.—L. **Mercier** and J. **Villeneuve**: Second contribution to the study of the anatomy of the head of the cycloraph Diptera; the lunula and its sensorial organs.—A. **Vandel**: Geographical spanandry (scarcity of males) in the Myriapod *Polyxenus lagurus*.—Gilbert **Ranson**: Nutrition in aquatic animals.

CALCUTTA.

Asiatic Society of Bengal, May 3.—Harit Krishna **Deb**: (1) When Kurus fought Pandavas. It would seem that the Kurus fought the Pandavas in the fifteenth century B.C. (2) The five-yearly yuga and the Saptarshi cycle. It is highly probable that about 1400 B.C. Garga enunciated the Saptarshi cycle in order to account for the apparent movement of the nakshatras in a direction retrogade to their daily motion, which was due, in reality, to an inherent small error in the lunar period of the five-yearly yuga, a yuga which, we know, was adopted by Garga.—R. B. Seymour **Sewell**: Maritime meteorology in Indian seas. Seasonal variation in the air-temperature over the open waters of Indian seas, the coastal region of the Andaman Sea, is recorded. Variations of other meteorological data are also discussed.—Sunder Lal **Hora**: Note on a hermaphrodite loach. An example of teratological hermaphroditism in *Nemachilus montanus* (McClelland).

ROME.

Pontificia Accademia delle Scienze (Nuovi Lincei), April 18.— — **Terkan**: New method of determining the luminosity and temperature of celestial bodies.—**Luigioni**: Two anomalies encountered in two coleoptera, *Timarcha Schenklingi* and *Dendarus tristis*.—**Gianfranceschi**: Law of distribution of the energy in the black body spectrum. The theoretical values furnished by the author's new formula are compared with the observations made on the solar spectrum.—Pagnini: The hypotheses on which the undulatory theory is based.—Giorgi: Reference is made to Miller's recent experiments, and also to those of Wataghin, who has subjected the ballistic theory of light to further test.—Zanon: The biology of *Thrips tabaci*. The last generation of this insect was found in the gall caused by *Schizomya pimpinellae* on wild fennel in the Roman Campagna.

Official Publications Received.

Scientific Papers of the Institute of Physical and Chemical Research. No. 48: On the Absorption Spectra produced by the Explosion of various Elements (Hg, Cu, Fe, etc.). By Takeo Hori. Pp. 69-78+5 plates. 70 sen. Nos. 50-51: La Konsisto de Magnezioksiklorida Cemento, de Tutomu Maeda kaj Sigeru Yamane; Viskozecoŝanĝo dum la Reakcio inter Magnezioksido kaj Magnezioklorida Akvosolvaĵo, kaj Nova Konsidero rilate al Hardiĝo de Cementoj, de Tutomu Maeda. Pp. 85-128. 50 sen. No. 52: Some Experiments on Spark Discharge in Heterogeneous Media—a Hint on the Mechanism of Lightning Discharge. By Torahiko Terada, Ukitarô Nakaya and Kiyoshiko Yumoto. Pp. 129-160+plates 7-14. 70 sen. No. 53: Influence of Vitamin A on the Absorption of a Foreign Fat. By Waro Nakahara. Pp. 161-166. 20 sen. No. 54: The Change of the Wave-length of the Cadmium Red-line (λ6438·7 Å). By Mitsuharu Fukuda. Pp. 167-170+plate 15. 20 sen. No. 55: On the New Lines $(1S-2p_{1,2})$ of Zinc, Cadmium and Mercury. By Mitsuharu Fukuda. Pp. 171-176+plate 16. 30 sen. No. 56: The Spectra of Metals under Heavy Current Excitation. By Mitsuharu Fukuda, Tamio Kuyama and Yasushi Uchida. Pp. 177-188+plate 17. 40 sen. (Tokyo: Institute of Physical and Chemical Research, Komagome, Hongo.)

Aeronautical Research Committee. Reports and Memoranda, No. 987 (Ae. 199): The Full Scale Determination of the Lateral Resistance Derivatives of a Bristol Fighter Aeroplane. By H. M. Garner and S. B. Gates. (A. 2. b. Stability, Full Scale Experiments 34—T. 2107.) (8 and C 119.) Pp. 16+8 plates. 1s. net. Reports and Memoranda, No. 990 (Ae. 201): Full Scale and Model Measurements of Lift and Drag of Bristol Fighter with R.A.F. 31 Wings. By B. D. Clark, Dr. R. G. Harris and L. E. Caygill. (A. 3. a. Aerofoils General, 158, A. 4. b. Full Scale Work 28—T. 2128.) Pp. 6+7 plates. 6d. net. (London: H.M. Stationery Office.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 562: Surface Water Supply of the United States, 1923. Part 2: South Atlantic Slope and Eastern Gulf of Mexico Basins. Pp. iv+86+8 plates. 15 cents. Bulletin 783-A: Mineral Industry of Alaska in 1924 and Administrative Report. By Philip S. Smith. Pp. ii+80+xvii. (Washington, D.C.: Government Printing Office.)

Publications of the Kapteyn Astronomical Laboratory at Groningen. Edited by Prof. Dr. P. J. Van Rhijn. No. 40: The Stars of High Velocity. By J. H. Oort. Pp. viii+75. (Groningen: Hoitsema Bros.)

Diary of Societies.

SATURDAY, JUNE 12.

Biochemical Society (in Wellcome Physiological Research Laboratories, Langley Court, Beckenham), at 11.45 and 2.30.—C. G. Pope: (a) A Direct Reading H-ion Meter; (b) The Surface Concentration of Phenol in Aqueous Solutions.—J. W. Trevan, H. Bainbridge, and J. H. Gaddum: Micro Volumetric Methods.—J. W. Trevan: A New Micro-Balance.—A. F. Watson and H. D. F. Langstaff: Stages in the Purification of Culture Filtrates of B. Diphtheriae.—C. Dorée and E. C. Barton-Wright: A Note on the Stone-Cells of the Pear.—R. L. M. Wallis: The Corpus Luteum and Cholesterol Metabolism.—D. T. Davies, F. Dickens, and E. C. Dodds: Observations on the Properties and Preparation of the Para-thyroid Hormone (Collip).—H. R. Whitehead: Phosphates and the Growth of Streptococci.—A. T. Glenny, C. G. Pope, H. Waddington, and U. Wallace: Variations in Immunity Response to Different Preparations of Diphtheria Toxin.—A. F. Watson and H. D. F. Langstaff: The Preparation and Some Properties of Purified Diphtheria Antigen.—J. W. Trevan and E. M. Boock: Some Physical Properties of Local Anaesthetics.—O. Rosenheim and T. A. Webster: (a) The Anti-rachitic Properties of Irradiated Sterols; (b) Note on Alleged Specific Colour Reactions for Vitamin D.

Mining Institute of Scotland (at Dunfermline).

MONDAY, JUNE 14.

Faraday Society (at Institution of Mechanical Engineers) (Discussion on Explosive Reactions in Gaseous Media), at 2.30 and 5.—Part I. Explosive Reactions Considered Generally:—Dr. W. E. Garner: Introductory Survey.—Prof. H. B. Dixon, J. Harwood, and W. F. Higgins: On the Ignition Point of Gases.—Prof. W. T. David: Radiation in Gaseous Explosions.—Dr. S. W. Saunders and Dr. W. E. Garner: Ionisation in Gas Explosions.—Dr. S. C. Lind: Ionisation and Gas Explosions.—Prof. R. V. Wheeler and Dr. W. Payman: The Uniform Movement of Flame.—Prof. W. A. Bone: Explosions at High Pressure.—Dr. Colin Campbell and Prof. H. B. Dixon: Explosion Wave in Cyanogen Mixtures.—At 7.45.—Part II. Explosive Reactions Considered in Reference to Internal Combustion Engines:—Sir Dugald Clerk: Introductory Survey.—Prof. W. T. David: Combustion in Gas Engines.—H. T. Tizard: Explosions in Petrol Engines.

Royal Irish Academy, at 4.15.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—Prof. H. A. Kelly: The Silence of God—How is it explained?

British Psychological Society (Education Section) (at London Day Training College), at 6.—Capt. H. S. G. Sutherland: The Correlation between Size of Family and Intelligence of the Children.

Royal Geographical Society (at Æolian Hall), at 8.30.

TUESDAY, JUNE 15.

Royal College of Physicians of London, at 5.—Sir Thomas Lewis: Observations upon Blood Vessels of the Human Skin (Croonian Lectures) (3).

Royal Statistical Society (at Royal Society of Arts), at 5.15.—Dr. E. C. Snow: Some Observations on Trade Forecasting and Prices.

Mineralogical Society (at Geological Society of London), at 5.30.—Dr. F. L. Stillwell: On the Nature of Berthierite.—S. I. Tomkeieff: On some Chloritic Minerals Associated with the Basaltic Carboniferous Rocks of Derbyshire.—H. E. Buckley: The Anomalous Optical Properties of Several New Series of Isomorphous Double Tartrates.—Dr. G. T. Prior: On the South African Meteorites, Vaalbult, Witklip, and Queen's Mercy.

Zoological Society of London, at 5.30.—Dr. H. H. Scott: A Mycotic Disease of Batrachians.—H. G. Jackson: The Morphology of the Isopod Head.—F. W. Edwards: On the Marine Chironomidae (Diptera); with Descriptions of a New Genus and Four New Species from Samoa.—P. A. Buxton: The Colonisation of the Sea by the Chironomidae (Diptera); with an Account of the Habits of a New Genus and Species in Samoa.—O. A. Merritt Hawkes: On the Massing of the Ladybird, *Hippodamia convergens* (Coleoptera), in the Yosemite Valley.—Dr. Marie V. Lebour: On some Larval Euphausiidae (Crustacea) from the Mediterranean in the Neighbourhood of Alexandria, Egypt, collected by Mr. F. S. Russell.—D. Bhatia: On Three New Species of the Genus Anadenus (Mollusca).—Prof. J. P. Hill and Prof. J. B. Gatenby: The Corpus Luteum of the Monotremata.

WEDNESDAY, JUNE 16.

Society of Glass Technology (at Sheffield), at 2.30.

Correlative Science Society (at Royal Botanic Society of London), at 8.—Chemical Physics—The Dynamics of Molecular Motions, Planetary Nebulae, Critical Velocity (Conference).

London Dermatological Society (at St. John's Hospital, Leicester Square), at 4.30.—Sir Humphry Rolleston, Bart.: The Relations of Dermatology and General Medicine (Annual Oration).

Royal Meteorological Society, at 5.—J. E. Clark, I. D. Margary, and R. Marshall: Report on the Phenological Observations in the British Isles from December 1924 to November 1925.—S. M. Bower: Report on Winter Thunderstorms in the British Islands from January 1 to March 31, 1925.—Dr. E. Kidson: Abnormal Rates of Ascent of Pilot Balloons in the Lower Levels of the Atmosphere at Melbourne.

THURSDAY, JUNE 17.

Royal Society, at 4.30.—Sir Arthur Schuster: A Review of Mr. George W. Walker's Magnetic Survey (1915).—Lord Rayleigh: The Continuous Spectrum of Mercury Vapour in relation to the Resonance Line 2536·52.—Prof. O. W. Richardson: Structure in the Secondary Hydrogen Spectrum. IV.—Prof. W. L. Bragg and J. West: The Structure of Beryl, $Be_3Al_2Si_6O_{18}$.—Prof. A. P. Laurie: On the Change of Refractive Index of Linseed Oil in the Process of Drying and its Effect on the Deterioration of Oil Paintings.

Institute of Pathology and Research (St. Mary's Hospital, Paddington), at 5.—J. E. Barnard: The Microscopy of the Filterable Viruses.

Royal College of Physicians of London, at 5.—Sir Thomas Lewis: Observations upon Blood Vessels of the Human Skin (Croonian Lectures) (4).

Chemical Society, at 8.—A. Hassell and Dr. C. K. Ingold: The Chemistry of Polycyclic Structures in Relation to their Homocyclic Unsaturated Isomerides. Part VII. Tautomerism corresponding with that of Nitrosophenol and Quinone-oxime in the Dicyclopentane Series.—F. R. Goss, Dr. C. K. Ingold, and I. S. Wilson: The Nature of the Alternating Effect in Carbon Chains. Part VIII. The Nitration of some Benzylamine Derivatives with Special Reference to the Respective Rôles of the Ions, Salts, and Bases.—E. L. Hirst: The Structure of the Normal Monosaccharides. Part V. Fructose.—W. N. Haworth and E. L. Hirst: The Constitution of the Disaccharides. Part XI. The Relationships of Fructose, γ-Fructose, and Sucrose.

Royal Society of Tropical Medicine and Hygiene (Annual General Meeting) (at 11 Chandos Street, W.), at 8.15.—Col. S. P. James: Epidemiological Results of a Laboratory Study of Malaria in England.—Presentation of the Manson Medal to Prof. E. Marchiafava, in recognition of the part he took, with other Italian Investigators, in the Elucidation of the Life-history of the Parasites of Human Malaria.

FRIDAY, JUNE 18.

Royal Astronomical Society (Geophysical Discussion), at 5.—Prof. E. V. Appleton and Dr. G. C. Simpson: Electrical Discharges in the Atmosphere. Chairman: Col. H. G. Lyons.

Royal Society of Medicine (Balneology and Climatology Section) (Annual Meeting), at 5.

Geologists' Association (at University College), at 7.30.—Dr. D. R. Grantham: The Petrology of the Shap Granite.—G. W. Young: Notes on the Shoshone Valley, Yellowstone National Park, U.S.A. (Lecture).

Royal Institution of Great Britain, at 9.—Seton Gordon: The Golden Eagle and its Neighbours.

Royal Society of Medicine (Study of Disease in Children) (at Children's Hospital, Birmingham).

CONFERENCES.

SATURDAY, JUNE 12.

Photographic Convention of the United Kingdom (at Edinburgh).

South-Eastern Union of Scientific Societies (at Colchester).—A. Farquharson: The Social Constitution of a County.—G. E. Hutchings: The Choice of Maps for Regional Surveys.—Dr. C. Tierney: Some of Nature's Secrets.

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The Universities and International Peace.

THE third Congress of the Universities of the British Empire, which is to be held at Cambridge next month, is an event of more than academic interest and significance. It proves that universities differing widely from one another in origin, traditions, constitution, organisation, and even the mother-tongues of the majority of their members, and some with the thick of the earth between them, are capable of friendly co-operative effort, sustained over a period extending now to fourteen years, in pursuit of common aims. Further, it shows that such co-operation is possible without external stimulus, pressure, or aid; above all, and in this it is characteristic of the forces which hold the British Empire together, in absolute independence of State inspiration, guidance, or subvention. The question suggests itself whether universities of other countries, outside the British Commonwealth of Nations, might not similarly co-operate internationally and thereby contribute more effectively than they do at present to international peace.

There is a peace that passeth all understanding, and when it shall prevail generally in the hearts of mankind, and especially in the hearts of politicians, high financiers, trade union leaders, and newspaper proprietors, humanity will have finally emerged from the jungle, and war will be a thing of the past. But peace in our time is largely conditioned by understanding, and whither should we look for help in the promotion of understanding if not to those foci of intellectual light—the universities? These do already, beyond question, give such help, but by independent and, to a great extent, unco-ordinated effort rather than by concerted action.

At Gex last August was held the fourth annual conference of the "Entr'aide Universitaire" (World Federation of Christian Student Associations). In the course of the proceedings a striking address was given by Dr. A. E. Zimmern on "The Contribution of the Universities to International Comprehension and, thereby, to International Peace." The League of Nations, Dr. Zimmern pointed out, was created to introduce more intelligence into international relations. What divides the nations at the present time is not hatred but ignorance, folly, and intellectual sloth. International relations are no longer confined to diplomatists and great financial and mercantile houses, but exist also between multitudes of ignorant people whom the progress of science in its applications to means of transport and communication have brought close together as in no previous period of the world's history. This approximation and this multiplication of points of contact implies increasing potential causes of friction. Hence an urgent need of promoting by all available means the development of a true citizenship of the world, such as can be brought about, not by travellers' tales, novels, and plays designed to gratify an idle curiosity, not by trade or by missionary enterprise, not even by collaboration of specialists—the internationalism of science, so highly developed and esteemed in the nineteenth century—but by full and frank and generous interchange of ideas between personalities determined to comprehend each other's attitudes and points of view and the modes of working of each other's minds. What, then, should be the contribution of the universities?

Universities have two aims; namely, the fullest and finest development of the national character, and the search for truth. In the pursuit of these they contribute to international peace, first, by providing a *milieu* most suitable for enabling a foreigner to learn to understand the national character, and, second, by research in the field of international problems and the bearing thereon of national temperaments and attitudes. Dr. Zimmern does not believe in the idea of an "International University," and holds that no good can come of diluting distinctive national characteristics with an insipid cosmopolitanism. On the subject of international university congresses he offers no opinion. Within a limited field, including such questions as co-operation in scientific research and facilities for visits by university professors and lecturers and advanced students of one country to universities in other countries, such congresses, suitably organised, might afford opportunities for just that personal intercourse, that full and frank and generous interchange of ideas of people determined and competent to comprehend each other, which are so urgently necessary. A handbook of international organisations, compiled by the League of Nations, gives particulars of some 350. Several of these, such as the International Research Council and the International Academic Union, are indeed closely concerned with university activities, and others, such as the International Federation of University Women, bring together students and graduates of universities of different countries, but universities themselves are conspicuous by their absence. Groups represented by 350 organisations have thought it worth while to devise machinery for cultivating international relationship, but the universities of the world have not thought it worth while or, if they have, lack the energy to embody the thought.

The subject will no doubt be explored by the Section of University Relations of the International Institute of Intellectual Co-operation recently established by the League of Nations at Paris. It may be surmised that in any further development in this direction that may take place due weight will be assigned to a principle the importance of which has been proved by the experience of one of the most effective of international organisations, namely, the Comité Maritime International. This is the principle of continuity of the *personnel* of the delegations: "The leading persons who attend the Conferences," says a report by Sir Leslie Scott, the senior British delegate, in the *Times* of April 16, 1926, "are to a great extent the same. But for the mutual confidence engendered through personal contact with the same men, it would never have been possible to reconcile many apparently irreconcilable differences. A spirit of trust and friendship has grown up, which continual changes of *personnel* would have prevented. . . . There is no better preventive of misunderstandings [than this plan of personal continuity in representation], and in order to overcome the inherent difficulties of different language, temperament, and outlook, it is perhaps an essential condition of successful progress."

In 1918, on the invitation of the Government of the United States, the universities of the British Isles sent a representative mission to America, and in the following year similar university missions were sent to France and Belgium. Much good feeling was generated by these friendly official visits, but the precedents thus set have not been followed. The Atlantic no doubt presents a formidable obstacle, but it is not clear why such missions should not be undertaken from time to time as between countries comparatively near to one another. The visits paid on such occasions as the celebration of a jubilee or a centenary commemoration of the founding of a university, valuable as they undoubtedly are, are generally very brief and ceremonious, and the hosts and guests have not much time or opportunity for exchange of ideas. On the initiative of the University of Basle in 1922, the universities of Great Britain and Switzerland experimented with another kind of international intercourse. Delegates met together at Basle as the guests of the university, and discussed in sessions extending over several days a number of subjects of common interest. This venture, like the missions to America, France, and Belgium, appeared to meet with the approbation of all concerned, but likewise has not, so far, been imitated.

The younger generation is in this matter giving a lead to those responsible for university policy. The Confédération Internationale des Étudiants, founded at Strasbourg in 1919, has now affiliated national unions of university students in almost every country of Europe and several countries in other parts of the world. Regional groups of students in the United

States are being organised with the view of affiliation. "The time has come," says a leaflet issued by the National Union of Students of England and Wales, "for the young men and women of the universities to undertake to a much greater extent than before the organisation of activities among themselves, linking up the life of each university much more closely with that of other universities, and providing facilities for themselves (such as tours, congresses, etc.) which will give them that wider experience so essential to the education of those who are to become the leaders of to-morrow. Such activities by no means impair the quality of academic work; rather they enrich and supplement it. For example, the N.U.S. arranges for its members faculty tours. . . . Each year medical, agricultural, engineering, theological, and art students visit the leading hospitals, laboratories, farms, factories, art galleries, etc., of the different countries of Europe." In the past it has been customary to look upon university student organisations only as appertaining to particular universities, and not as having national or international activities. In the changed conditions of to-day it behoves the universities to consider whether it is wise to leave the cultivation of the international field so largely to their undergraduate and youthful graduate members and, it may be added, university women, whose International Federation, though not rivalling the Confédération Internationale des Étudiants in membership, is rapidly extending its influence.

More effective than such missions or conferences are, perhaps, academic institutes in foreign countries, a subject which was discussed at length at the annual conference of universities of Great Britain and Ireland in 1925. In this direction the Office National des Universités et Écoles Françaises has been very active, and there are now French Institutes in London, Florence, Naples, Madrid, Barcelona, Prague, Sofia, and Buenos Aires. The United States has, since the War, undertaken a peaceful penetration of universities on the eastern side of the Atlantic by means of the American University Union in Europe, with divisions at Paris and London. The establishment of branches of the Union in Rome, Berlin, and Vienna has been suggested, an American Institute has been founded at Prague, and there are at Geneva an International Educational Institute and an International Students' Union, both financed from America, whilst an American committee of the Geneva Institute of International Relations maintains an office for the reception of English-speaking visitors who come to Geneva to study international co-operation. This office was visited during the summer of 1925 by about 5000 Americans. The newly constituted Comité d'Administration of the European centre of the Carnegie Foundation for International Peace contemplates the formation of American Institutes at Berlin, Warsaw, Madrid, Rome, and in the Balkans as well as in the Far East, South America, and Mexico. All these American enterprises differ from the French Institutes in that they are entirely independent of State control. The same applies to the only comparable British Institute—that at Florence—but not to the Pan-American Union, which, through its Educational Section, keeps the Latin American universities in touch with one another.

Among other institutions through which universities exert an important influence on international relations by promoting international comprehension are university fellowships tenable in foreign countries for advanced study and research, and university vacation courses for foreigners. But, after all, the greatest contribution the universities can make to the cause of international peace is one which Dr. Zimmern seems to have overlooked. As Mr. Stanley Baldwin explained with admirable force and lucidity in his address entitled "Truth and Politics" on his inauguration as Lord Rector of the University of Edinburgh, the most important task of a university student is to learn to think clearly, to learn habits of precision in statement, honesty in handling evidence, fairness in presenting a cause—in a word, to be true in word and deed, and it is truth and the habit of truth alone that will "destroy the face of the covering cast over all people, and the veil that is spread over all nations" (Isaiah xxv. 7).

Science and the Modern World.

Science and the Modern World: Lowell Lectures, 1925. By Prof. Alfred North Whitehead. Pp. xi+296. (Cambridge: At the University Press, 1926.) 12s. 6d. net.

IT is fortunate that in the twentieth century, science and philosophy are beginning to be united in the same person as they were in the seventeenth century before their fatal divorce occurred. Prof. Whitehead's latest book cries out to be read and re-read and meditated upon (and to that end if possible possessed) by every man of science who is not content to live merely in his own special 'groove of routine' and is concerned in the trend and tendency of science as a whole; and by every philosopher who desires, as he must, to keep himself in contact with the thoughts of science. It is a work not only of the first importance but also of great beauty. Apart from the vivid writing, the reader's delight arises from two sources: in the first place, from the rapid characterisation of the various epochs into which Prof. Whitehead divides the history of modern scientific thought; and secondly, from his method of pointing out in each epoch just how the central thought of the epoch bears, in the way of contribution or of defect, upon the central thought of the present as the author conceives it. The poet prefiguring him wrote: 'and as he works, the industrious bee computes *his* time as well as we.' One result of this procedure is that while the bulk of each historical chapter is simple and luminous reading, each chapter contains a few pages which demand the closest attention, but work with cumulative preparation towards the dramatic outcome.

The plan of the book is to begin with the origins of modern science out of the Middle Ages, and then after a sketch of the history and nature of mathematics, to take in succession the outstanding movements of thought—the seventeenth century, which Prof. Whitehead calls the century of genius, the eighteenth century, the romantic reaction of the earlier nineteenth century, and then the nineteenth-century science, which is followed by an account of the theory of relativity and the quantum theory. Certain chapters follow, to which I shall return presently. The historical surveys—if I may call them so—are distinguished not so much by any learning which would cause surprise in reading an author whose wide cultivation and breadth of human interest are so well known, as by the freshness and originality with which the salient features are seized. With all its rebellion against the rationalism of the Middle Ages and its appeal to Nature as the fountainhead of knowledge, and submission to "irreducible and stubborn facts" (as he quotes from William James), modern science owes to the medieval rationalism its belief in natural order; and to its insistence on 'the rationality of God conceived as with the energy of Jehovah and with the rationality of a Greek philosopher,' its 'belief in the connexion of every occurrence with its antecedents in a perfectly definite manner, exemplifying general principles.'

The service of Bacon to the new learning is acknowledged with a cordiality and discrimination which contrast refreshingly with the recent meagre and grudging commemoration of his anniversary, in an age which forgets his scientific inspiration because he was a disagreeable person and exaggerated the reach of his inductive methods, though even there it might be remembered that he taught the importance of negative instances. Berkeley is singled out as perhaps the most fruitful mind of the eighteenth century, though he affected little the course of science. The chapter on the Romantic Reaction contains a striking study of Wordsworth and Shelley as supplying, one in antagonism to science, the other, Shelley (as he urges in a very interesting passage), in full sympathy with science, the feeling for the æsthetic concreteness of Nature, as a whole and in its parts, which the 'materialism' of science lacked. (In interpreting 'the light that never was on sea or land' as the eternal objects of philosophy, Prof. Whitehead has overlooked Sir Walter Raleigh's exposure of that general misunderstanding, "Wordsworth," pp. 107 ff.) The greatest invention of the nineteenth century he declares was 'the invention of the method of invention.' But these chapters are packed with illuminating aphorisms.

The greater part of the book consists of Lowell Lectures given at Boston, and is, therefore, a hemi-semi-popular version of Prof. Whitehead's philosophy of Nature as approached from the history of science. It has thus the advantage of insinuating into the scientific reader's mind by a study of science itself the conceptions already reached. But it does much more. It presents the main drift of the author's former work with a clearness not before exhibited and perhaps not before completely attained; and it makes new and important additions. Prof. Whitehead's chief interest is to substitute for the hitherto prevailing 'scientific materialism,' as he calls it, or 'mechanism,' with its underlying conception of individual bits of matter in motion, the conception of 'organism.'

The first conception became fixed in thought with Descartes Its immense service for science Prof. Whitehead does not, of course, deny, but it is an abstraction which has broken down in the history of science itself. Through the influence of biology and physiology, and now of psychology, the notion is imposing itself that the enduring things are organisms, and the present condition of physics itself he compares to the condition of astronomy when people began to help themselves with the introduction of epicycles—a sure sign of the need for change. He puts the difference this way (p. 81): On the current theory a bit of matter has *simple location*, that is 'in expressing its spatio-temporal relations it is adequate to state that it is where it is, in a definite region of space, and throughout a definite duration of time, apart from any essential reference of that bit of matter to other regions of space and to other durations of time. The organic theory asserts not only internal relatedness within the enduring thing, but interaction between all things.' He goes so far as to deny that even spatio-temporal relations between things, generally regarded as external, are so (p. 174). When it is more fully analysed, this means that each thing in Nature mirrors all the rest, or is what he calls a 'prehension' of them; a modification of Leibnitz's doctrine (in which he agrees with writers like James Ward and others), by which the entities in relation are not windowless but are in communication with all others, as it were by tubes of force.

This thoroughgoing interrelatedness of events is part and parcel of Prof. Whitehead's concrete treatment of

Nature, only he has never expressed it so explicitly as in this book. Space-time is for him no mere framework into which things fit; but Nature, which is essentially passage or transition, consists of events, and events are slabs or 'durations' (or portions of such) in this passage presented in sense, in which what he calls 'objects' (or what others have called 'universals') are 'ingredient' and have 'situation.' In this book there are introduced at least two new conceptions, that of 'endurance' or 'reiteration,' and that of 'value.' Enduring objects are the persisting patterns in which complex eternal objects (like yellow, hard, soluble in nitric acid, etc.) are actualised in union—not necessarily unchanging patterns, but it may be a pattern which is realised in succession like that of a musical melody.

The other notion of 'value' is that which is yielded by the suggestion of the romantic poets. Value is the intrinsic reality of an event, and realisation is in itself the attainment of value. It is, in other words, what an event counts for in the whole and therefore varies in degree. But always the wholeness or concreteness of events is given fact, and an 'æsthetic attainment is interwoven in the texture of realisation' (pp. 131-2). (I do not know if this meaning of value coincides with the ordinary use of value in speaking of goodness, truth, and beauty as values; but I incline to think it does.)

Finally, going beyond Prof. Whitehead's previous work into what must be supposed to underlie Nature as a whole and its parts, we have the notion of an eternal activity, which takes the place on this theory of Spinoza's 'Substance' (a notion tainted, of course, with the static conception of the seventeenth century), which realises itself in a hierarchy of emerging entities, themselves 'structures of activity' which are evolved, whereas on the mechanistic theory there is but material which endures.

These necessarily brief and condensed outlines might gave the impression that the book largely moves among attenuated conceptions. The reverse is the fact; it is always a man of science using philosophy as a critic of abstractions. The physicist in particular may find discussions of pending physical problems in the highly suggestive interpretation in Chap. ii. of the strange discontinuity in the paths of electrons within the atom, so that they occupy a series of isolated dots rather than a continuous line; and in the treatment in Chap. viii. of the quantum theory on the lines of the organic conception. These suggestions I must content myself barely to refer to.

The most difficult part of the book concerns Prof. Whitehead's differences from the orthodox treatment of relativity and in particular his conception of time. Time is distinguished from duration. In a duration we have measurable or, as Prof. Bergson says spatialised, time. Time itself is denied to be extensive (and indeed it is fairly clear that as a dimension of the spatio-temporal nature time cannot be of the same sort as the dimensions of space). But we are then met with the doctrine that time is a sheer or atomic succession of 'epochal durations'; the time within the duration being needed to secure the realisation of the enduring objects. These are stiff considerations, and I confess that I have not yet been able to get inside them completely. In other words, I cannot at present find room for any time except what is implied in the spatio-temporal process. All the more reason for myself and others to penetrate them, for they are an essential part of Prof. Whitehead's speculations. They are intimately related with some other features of the doctrine, the suggestion (p. 131) of a wider evolution beyond Nature itself, and within which Nature is but a limited mode, the hint here and in earlier work of a transition from Nature to what is left unexplained under the designation of 'mind' (for when Prof. Whitehead speaks of perceiving or a percipient event, this is but a bodily event, the functioning of which is consciouness, and he very forcibly observes *à propos* of some interpretations of relativity as an affair of the mind, that what we are concerned with is not the observer's mind but his body); finally, the whole relation between the world of eternal objects and the actual world.

As to the rest of the book, I can barely mention the last two chapters, one on religion and science which is quite admirably done, and the last on requisites for social progress, which largely turns on the correction of our specialised education by the cultivation of sense for concrete organic wholes, that is in the widest sense of 'art.'

Two other chapters, x. and xi., on 'Abstraction' and 'God' do not belong to the original Lowell lectures, and though they are a completion of the conception of the book and necessary to Prof. Whitehead's thought, and from the philosopher's point of view the most important novelty of the book, do, to some extent, interfere with the artistic unity of the work. They are an exquisite piece of metaphysical work, as if one were hearing a new Plato expound the relation of 'forms' (ideas) to actual reality, and the intercommunion of 'forms.' But they are too condensed to bear reproduction, and they will be of less interest to the purely scientific reader. For the same reason I omit any attempt to affiliate Prof. Whitehead with other, living or recent, philosophers—a subject of great interest. We may hope that we shall not have to wait long for fuller exposition of these matters and more light upon some of those difficulties to which I have referred. Meantime we must be thankful for the present book, which is without any exaggeration one of immense significance.

Against a second edition I note a few trifling misprints: p. 20, line 10; p. 101, line 13; p. 105, line 10; p. 160, line 7; p. 177, line 9 from foot; and add a query as to whether there is not some mistake in the second 'impassible' (p. 11). A misprint on p. 117, 'thoughts too deep for terms,' is too poignant for tears.

S. ALEXANDER.

The History of Electrical Communication.

Board of Education. Catalogue of the Collections in the Science Museum, South Kensington; with Descriptive and Historical Notes and Illustrations. Electrical Communication. 1: Line Telegraphy and Telephony. Compiled by R. P. G. Denman. Pp. 55+12 plates. (London: H.M. Stationery Office, 1926.) 9*d*. net.

TO derive the full educational benefit from a science museum, it is necessary to read a good descriptive and historical catalogue of the exhibits before visiting it. This section of the catalogue of the Science Museum, South Kensington, describing line telegraphy and telephony excellently fulfils this purpose. As the exhibits described are typical of the various stages of the development of the art, it will prove very helpful to every student of applied electricity, whatever his age may be.

In the introduction the earliest attempts at electric signalling are described. It is related how in 1730 Stephen Gray demonstrated by means of frictional electricity that a down feather could be moved at a distance of 800 feet. A few years later the Abbé Nollet formed a ring of Carthusian monks, 1800 yards in length, holding on to iron wires which connected them in series. He then discharged a battery of Leyden jars round the loop. The simultaneous leap made by each monk proved the rapidity of the discharge, and that its intensity was practically the same at all points. Desaguliers repeated some of Stephen Gray's experiments in 1738. It is interesting to remember that the Royal Society gave the first Copley medal to Gray and the second to Desaguliers. The latter received no less than three Copley medals, thus beating Faraday, who only received two. Cawthorn, in his "Vanity of Human Enjoyments," thus relates his end.

"Can Britain . . .
. . . permit the weeping muse to tell
How poor, neglected Desaguliers fell?
How he, who taught two gracious kings to view
All Boyle ennobled, and all Bacon knew,
Died in a cell, without a friend to save,
Without a guinea and without a grave."

The last of the frictional electricity systems was developed by Sir Francis Ronalds in 1816. After this, inventors turned their attention to the much more convenient voltaic systems. Wheatstone and Cooke took out their first patent in 1837 for a method for giving signals by means of electric currents. A few years later a telegraph was working between Paddington and Slough, a distance of 18 miles. In 1843, with funds granted by Congress, Prof. Morse constructed a line between Washington and Baltimore. The armature on the receiving instrument moved backwards and forwards printing zigzag lines on a moving strip of paper. This instrument was later supplanted by the 'sounder,' operators finding it easier to listen to the clicks of the armature against the upper and lower stops than to read the slips. Messages with this instrument can be sent at the rate of 40 words a minute. Cooke and Wheatstone's revolving disc telegraph of 1840 reminds one of some of the apparatus used in modern automatic telephony. Hughes's type printing telegraph still survives.

Exhibit No. 2 shows Ronalds's 1816 telegraph and gives a vivid picture of science at that date. The invention was brought to the notice of the Admiralty, who thought it "wholly unnecessary." Ronalds therefore never proceeded with it. No. 7 shows Cooke's original electric alarum. Finding that this instrument did not work satisfactorily, Cooke consulted Wheatstone. This resulted in one of Wheatstone's greatest inventions—the relay—developments of which are in use in practically all modern telegraph systems. Wheatstone's five needle instrument (exhibit No. 9), made in 1837, consisting practically of five galvanometers, shows some of his methods of overcoming difficulties. No. 30 shows the Fullerphone, an instrument used extensively in the War. By means of this instrument both telegraph and telephone services can be worked simultaneously over the same wire.

There is an excellent exhibit of Murray automatic printing telegraph apparatus, a system which may be extensively used in the future. The submarine cable exhibits are very interesting. A specimen of the first cable laid between Dover and Calais in 1850 is shown. We always understood, however, that it was the anchor of a French fishing smack that broke the cable and not the action of the tides. One of the first mirror galvanometers, designed in 1858 by Lord Kelvin, then Prof. W. Thomson, is shown (No. 60). Then we have the siphon recorder and specimens of early Atlantic cables.

Varley's carbon lightning protector (No. 88), patented so far back as 1866 by the brothers Varley, consists of two copper points nearly touching one another in a small box filled with powdered carbon. It is supposed to be a non-conductor up to a definite voltage and a conductor for a higher voltage. Something similar to this was invented by the French electrician Thury some years ago for use on his high-tension direct-current system. It seems to the writer that if something thoroughly trustworthy of this nature were invented it would perform admirably the functions of an electrical safety valve and a lightning protector.

There is a good exhibit of telephone transmitters and receivers. The Strowger automatic telephone sets and the working model of the automatic telephone system for the London area will interest many. The model is probably for its size the most complex mechanism extant. Six exchange switching centres are represented; access to these can be obtained by a number of automatic telephones included in the exhibit. Visitors may make test calls with these instruments and trace the progress of their call through the successive pieces of apparatus. They can also see how the call proceeds from one automatic exchange to another or a manually operated exchange. The telephone call meter (No. 136), which registers the number of effective calls made by a subscriber, is of general interest.

An interesting exhibition of telephotographs (No. 140), presented by the International Western Electric Co., shows the degree of technical excellence to which the transmission of pictures over long telephone lines has now been carried. This application of science has been rendered possible by the grouping of many modern inventions together. The thermionic valve, the carrier current transmission system, and the photoelectric cell are all used in the system. The method is a trustworthy one. A positive transparency prepared by any photographer can be sent, even although still wet, over telephone lines of any length in a few minutes, and after the usual photographic development of the received picture it can be produced in a newspaper.

A. R.

Nitrogenous Derivatives of the Sugars.

Hexosamines and Mucoproteins. By P. A. Levene. (Monographs on Biochemistry.) Pp. x + 163. (London: Longmans, Green and Co., 1925.) 10*s.* 6*d.* net.

DR. LEVENE'S monograph deals with an important group of natural compounds, closely related to the simple sugars. Some of the properties of the parent-compounds are described briefly in the first chapter, in which the existence of ring-systems of different size is referred to; but Haworth's proof that even glucose itself contains a 6-atom instead of a 5-atom ring calls for a further revision of formulæ which have been accepted for a generation without any foundation of experimental proof. The remarks of the author, in reference to chitosamine, that "much of the chemical structure of the sugar was formulated correctly rather by instinct than by experimental evidence," appears to be capable of a much wider application, but with a reservation as to the necessary correctness of the 'instinctive' formulæ.

The following chapters of the book deal with the hexosamines and their derivatives, with the hexosaminic and aminoheptonic acids and with the anhydrohexoses. Important sections are devoted to the configuration of these sugar-derivatives, and the study of this problem has led the author inevitably to the problem of the Walden inversion in the sugar series, on which he is now undertaking experimental work with the view of determining whether a change in polarity of a group attached to an asymmetric carbon atom does or does not change the direction of rotation.

The later part of the book deals with mucoproteins. These are complex proteins, in which the protein part varies widely from tissue to tissue and from species to species, whilst the carbohydrate group is always linked with sulphuric acid, the group being built up from equimolecular proportions of sulphuric acid, acetic acid, hexosamine, and glucuronic acid. These complex compounds have been made the subject of an intensive chemical investigation, in the course of which new ground has been broken in the preparation of sulphuric esters of simple carbohydrates. The field for investigation is a very wide one, and there are many difficulties to be overcome; but the author has given an admirable review of the present position. His chapters on 'Methods' describe the basic chemical operations which must precede any further investigations in this direction.

Bird Life and Natural Selection.

Indian Bird Life: or the Struggle for Existence of Birds in India. By Douglas Dewar. Pp. xv+276. (London: John Lane, The Bodley Head, Ltd., 1925.) 7*s.* 6*d.* net.

WE congratulate Mr. Dewar in having written the best of the very numerous books which he has brought out. In his introduction he rather frightens us when he hints that he is going to show us to what extent Darwin was right or the reverse in his theories. As we read, however, we find that this apparently is not his object, and that all he intends to do is to quote examples of how natural selection may be influenced by environment or, in some cases, how neither natural selection nor environment can, in his opinion, account for what happens. The author's quotations are well selected but his theories are quaint. There are but few scientific workers who will agree with Mr. Dewar's theory that much of what occurs in life is due to 'luck.' On p. 260 he remarks, "the struggle for existence of birds results in the weeding out of the unlucky rather than the less fit." We hope that when Mr. Dewar has again perused his own work and the excellent examples given therein of the survival of the fittest, he will feel in a position to change his mind. The book consists of a compilation of facts and statements recorded by others, but Mr. Dewar has done an excellent piece of work in bringing these same facts and statements together and in arranging them in so readable and interesting a form. The reader can draw his own conclusions from what is written, and, even if these conclusions do not agree with those of the author, he will be none the less indebted to him.

Mr. Dewar's observations on the extraordinary mortality amongst young birds and upon the small percentage of eggs which ever hatch are most interesting although very far from complete. The chapter on competition for nesting sites is not so good, for we have more of the author's deductions and fewer facts from other people, whilst in some places he undoubtedly goes astray both in his facts and in his conclusions. This is especially the case when he dilates on the life history of some of the parasitic cuckoos, for he has apparently not read certain recent papers in the *Proc. Zool. Soc.* showing how over-production of the eggs of cuckoos, where these birds become too common, works out their own destruction.

We think Mr. Dewar will also have some difficulty in convincing his readers that his conclusions as to breeding behaviour are correct. Thus we notice that he considers lapwings and other birds which try to draw intruders from the vicinity of their eggs or young by feigning injury, are merely the victims of unbalanced minds. Those who have seen birds behaving in this manner and not merely read articles referring to them, know well that such birds show most conclusively in many ways that they are acting for the definite purpose of saving their property. Whether, however, we agree with Mr. Dewar's conclusions or not, every one interested in the question of evolution and environment should read his book, and we may end as we began by congratulating him on having compiled a work which is a desideratum for all naturalists.

Our Bookshelf.

Health and Environment. By Leonard Hill and Argyll Campbell. Pp. xix + 208 + 8 plates. (London: Edward Arnold and Co., 1925.) 12*s.* 6*d.* net.

THIS handbook deals in the space of two hundred pages with subjects of so personal and intimate a character that there is not a single individual who could fail to be interested by a very large portion of it, especially as it contains a good deal of straight talk on clothes, food, light, and open air. The subject matter, though presented in non-technical language, is based on sound scientific investigations which may be examined more fully in the Medical Research Council's Special Report Series, Nos. 32 and 52 dealing with "The Science of Ventilation and Open-air Treatment," Parts I. and II., and No. 73 "The Kata-thermometer in Studies of Body-heat and Efficiency," written by Prof. Leonard Hill. These two authors have rendered a social service in presenting to the individual a rational method of 'keeping fit' and in laying down the guiding principles for the heating, lighting, and ventilation of factories, schools, public and other buildings where large numbers of people congregate. In this connexion the book is of especial value to employers of labour and public health bodies.

Our daily papers have recently shown the only too frequent outbreaks of fire in country houses. Here we see the installation of modern systems of lighting and heating in old structures, never intended for them, followed by a very obvious and expected result. Results not quite so obvious must accrue from the present-day practice of designing of houses by architect's draughtsmen without the co-operation of sanitary engineers from the outset; the latter are called in only when new houses are nearing completion. The book establishes a plea for the designing of suitable systems of heating and ventilation before the foundations of buildings are laid.

One of the present authors was the first to stress the importance of the tonic effect of moving-air upon the human body, and it is in the correlation of this with a sense of comfort and general well-being that the kata-thermometer designed by Prof. Hill has been of such great use. Diagrams illustrating the use of this instrument and the results obtained with it are given. These are very clear, with the exception of Fig. 13, which has suffered in reproduction.

Employers of labour will be specially interested in the inexpensive improvements suggested in their trades, whereby the comfort and efficiency of the worker are enhanced and the output consequently increased.

To physicists, the description of the kata-thermometer designed by Prof. Hill and its recording pattern evolved by E. Schuster may not be new, but the results of its applications are likely to prove interesting. A detailed account of these instruments is given at the end of the book specially for the information of ventilating engineers.

Insulated Electric Cables. By C. J. Beaver. In Two Parts. Part I. Materials and Design. Pp. 264. (London: Ernest Benn, Ltd., 1926.) 36*s.* net.

ALTHOUGH the manufacture of electric cables is a comparatively recent industry, the progress that has been made in their design and method of manufacture is most satisfactory. In the early days of electric lighting it was common to use bare conductors laid in pipes filled with oil, the wrappings of the conductors being used simply as spacing materials. In the Edison system, for example, the conductors consisted simply of copper rods wound over with jute rope and drawn into iron pipes. The Crompton system also, which consisted of bare strip conductors in a culvert, was extensively used in the early days, and some of it is in use to-day after thirty years' service. The great improvements that have recently been made in cables are mainly due to the great encouragement given by the manufacturers to mathematical and physical research. In this volume Mr. Beaver discusses the materials used in the manufacture and the design of electric cables. An excellent résumé is given of the latest practice and the most modern theories which are used in design.

So far as conductors are concerned, aluminium seems to be coming to the front. A very careful comparison is made of the relative properties of conductors. It is pointed out that for conductors of equal resistance, aluminium conductors are only half the weight of copper conductors. Hence as the price of aluminium per pound is less than double the price of copper, aluminium conductors are indicated for many purposes. During the War, Germany was very short of these metals and so invented a method of producing zinc in the form of a ductile wire, but its low melting-point renders the soldering of joints with this material a very difficult operation. The increasing use of high pressures has made very elaborate researches on the properties of dielectrics necessary. The author describes many of these problems. Reference is made to the use of vulcanised bitumen as an 'ozone-proof' covering for rubber dielectrics. We can recommend this book.

Rambles in Vedânta. By B. R. Rajam Aiyar. Being a Collection of his Contributions to the *Prabuddha Bhârata*, 1896–98. Pp. xlvi + 888. (London: George Allen and Unwin, Ltd., 1925.) 12*s.* 6*d.* net.

RAJAM AIYAR, scholar, poet, and philosopher, was born in 1872 at Batlagundai, a village in the Madura district. He entered the Christian College, Madras, in 1887, graduating in 1889, and attended the Law College for three years. He then devoted himself for a time to letters, but later turned to philosophy and religion. After a period of preparation he took up what can only be described as the rôle of an evangelist. He founded a monthly magazine, *Prabuddha Bhârata*, which ran for two years with some success, but was brought to an end by his premature decease at the age of twenty-eight years. This brief sketch of his career is necessary for a just appreciation of this reprint of some of his work. In "Rambles in Vedânta" we have a number of the articles, poems, aphorisms, essays, and tales which he contributed to the magazine, both under his own name and under various pseudonyms. He himself describes them as an exposition of the principles of the ideals of the Vedânta which he aimed at presenting in their purest and simplest form, removing the misconceptions and mysticism which had gathered round them. He had studied arduously the Upanishads, the Gita, and the work of Sankara to this end. But his interpretation was peculiar and individual; and his work shows that he had been strongly influenced by his reading in English literature, of which he had a real and keen but critical appreciation. If, therefore, his guidance in Hindu philosophy and religion can be accepted only with some reserve, the book is none the less valuable to Western readers as affording an insight into a personality which could perhaps have been produced nowhere but in the India of the end of the nineteenth century.

The Pathology of Tumours. By Prof. E. H. Kettle. Second edition. Pp. viii + 285 + 4 plates. (London: H. K. Lewis and Co., Ltd., 1925.) 12*s.* 6*d.* net.

THE second edition of Prof. Kettle's book is arranged on the plan of the first, with the addition of many new diagrams and some revision of the text, particularly in the section on the general biology of tumours. The substitution of drawings for many of the photographs contained in the previous edition is a welcome improvement, since to the student entering on the study of pathology photographs are rarely satisfactory. The inclusion of a chapter on treatment is unusual in a volume of this type, but it is not altogether out-of-place, and a correlation of pathology and therapeutics enables the student more readily to grasp the general principles of both these branches of medicine.

Prof. Kettle's brief summary of the experimental study of cancer is excellent. He recognises fully the value of research work on the tumours of fowls and animals, considering it proved that the criteria by which we recognise a malignant tumour in mankind hold good in the mouse and other creatures. The work of W. E. Gye raises questions of the first moment, and "the parasitic nature of, at any rate, one form of malignant growth would seem to be proved."

The book is very well illustrated and indexed, and for medical students is ideal as an introduction to the subject of neoplasms and to the study of pathology in general.

A Text-Book of Inorganic Chemistry. Edited by Dr. J. Newton Friend. Vol. 3, Part 1: The Alkaline Earth Metals. By Dr. May Sybil Burr (*née* Leslie). (Griffin's Scientific Text-Books.) Pp. xxvi + 346. (London: C. Griffin and Co., Ltd., 1925.) 20*s.* net.

THIS part of Dr. Friend's "Inorganic Chemistry" deals with the triad of alkaline earth metals (calcium, strontium, barium) and with radium and its compounds. It contains an immense amount of detail, as is indicated by the fact that the footnotes include on the average at least one reference for every three or four lines in the text; but for this very reason the book is much more suitable for use as a work of reference than for continuous reading. In accordance with general policy, illustrations have been restricted to half-a-dozen equilibrium diagrams, and no figures are given of the plant used to manufacture products such as calcium carbide, cement, or glass. Special attention has been paid to agricultural questions arising out of the use of calcium cyanamide and of calcium phosphates as fertilisers.

La lumière et les radiations invisibles. Par Prof. A. Boutaric. (Bibliothèque de philosophie scientifique.) Pp. 284. (Paris: Ernest Flammarion, 1925.) 10 francs.

THIS book gives a somewhat popular and non-mathematical survey of the theories of light and the phenomena of radiation. It embraces a very wide range of phenomena, including, for example, the colour of the night sky, the pressure of light and its cosmic importance, and the behaviour of a ray of light passing through a gravitational field. The final chapter deals with the ether and is very well written; the more difficult experiments associated with the ether are described in an appendix.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On Prof. Miller's Ether Drift Experiment.

SOME time ago I was told (I think by Prof. R. W. Wood) that the late Prof. Morley had expressed himself as anxious about the immense superstructure that had been built on the null result obtained by Prof. Michelson and himself during a comparatively few very careful experiments. He was anxious that the experiment should be repeated under different conditions and the result confirmed. We now know that such repetition has been undertaken, at first in connexion with Prof. Morley, by Prof. D. C. Miller of Cleveland, for whose zeal, enthusiasm, and enterprise we must feel high admiration. Not six or a dozen repetitions, but thousands of them, have now been made, on the tops of mountains, on plains, with frames of different materials, and with a sufficient length of light path to give a result of 1 part in 1000 million. The undoubted result of these repetitions has been to confirm the null result of Michelson and Morley, so far as regards the orbital motion of the earth, and thereby establish one of the foundations on which the theory of relativity was at first based, up to what at that date had seemed to be the probable errors of experiment.

Whether there is anything more to be deduced from Prof. Miller's results (he clearly thinks there is) is a matter which is manifestly *sub judice*. His first *reported* claim, that the result on the top of a mountain was much greater than on a plain, could scarcely be accepted. If that had been true, the ideas involved would have been extremely difficult and revolutionary. It is a relief to know that that, at any rate, is no longer urged. The place at which the experiment is performed seems to matter not at all; and that is a great simplification, for it enables us to open our minds to see whether there is anything that can be admitted in his present claim. Prof. Miller has studied and plotted all his results in an admirable manner; and the only question is whether the outcome should be considered as practically zero, or whether (as he believes) there is a real residual effect which has to be accounted for.

What Prof. Miller now claims to have detected is a drift of the solar system in a direction approximately normal to the plane of the ecliptic, a drift which could not have been observed under the conditions of the early experiments. But the pressing question is whether such a drift has been observed now. That it is contrary to the main postulate of the theory of relativity, namely, that no effect due to motion through the ether can ever be observed, or, in other words, that everything goes on as if the ether did not exist, cannot be cited in opposition. For that is just the postulate which is under examination, and it has never been finally proven; though it has been made plausible by the verification of deductions made by its aid.

The argument of Prof. Miller, as I understand it, is that there is a slight residual effect due even to the earth's orbital motion, but so small that it comes within the limits of what is possible to observe. The effect is by no means of the full magnitude, but is, as it were, diluted down to (say) one-fifth of its theoretical value by some unknown cause, which he conjectures may be the FitzGerald-Lorentz contraction. It seems just possible that the FitzGerald contraction, though shown by Lorentz to compensate, does not compensate completely. Whether the compensation is complete or not, however, is a theoretical matter of some difficulty, which has not yet been thoroughly gone into, so far as I know, though reference may be made to a short paper by Sir Joseph Larmor in the *Phil. Mag.* for June 1904. If any good reason can be adduced for an outstanding discrepancy, that would strengthen Prof. Miller's position enormously; but until such reason is forthcoming the discrepancy must be doubted.

Assuming for the moment that the orbital motion does show a very slight and imperceptible or barely perceptible residual effect, Prof. Miller claims a larger effect, even ten times as large, which, plotted in accordance with sidereal time, could be accounted for by a cosmic drift of considerable magnitude if that too were diluted down by the same unknown cause and in the same ratio. He does not claim that the main drift of the solar system is observed, but only a residual fraction of it; and unless some reason can be given why there should be this residual fraction, and why the compensation should not be complete, it is dangerous to accept the result as certain, in spite of the skill with which Prof. Miller disentangles it from his multitude of observations and presents it as a small but recognisable and definite result.

The great importance of such a result, if it can be established, must make us very wary in accepting evidence for it, especially in view of the many disturbing causes. Hitherto the observations have been plotted with the view of displaying the reality of this supposed ether drift. But suppose they were plotted with some other object in view. For example, suppose they were plotted on the hypothesis that the south side of the housing of the instrument was slightly warmer than the north side. How would the average curve agree with that? An interferometer with so long a length of light path is a terribly sensitive instrument. The heat of the source of light, the warmth of the body of the observer, the exposure to radiation from the sun on one side and into space on the other, have all to be carefully considered. It is rather surprising that the readings were made by a peripatetic observer, with the instrument in constant and not very slow rotation. Under those conditions even the rotation of the earth might have a gyrostatic influence, and one would have thought that a stoppage of the frame and a reading of the fringes by a seated observer in many azimuths, would have been more satisfactory. It must be admitted as unlikely that an ether drift has been discovered by optical means; but the unlikely is not the impossible.

Assuming that the operations have been made with the cold-blooded and skilled accuracy of a Greenwich observer without regard to any theory whatever, and that the residual effect is genuine, then some result ought to be deduced; whether it be the important one claimed by Prof. Miller, or some more commonplace explanation. Meanwhile, one undoubted result does emerge from all this labour, namely, that the certain motion of the earth in its orbit fails to give any but a minute residual and doubtful effect—which is just the conclusion put forward by Michelson and Morley, a conclusion hitherto accepted by the scientific world. Beyond that there remains a residual effect to be discussed, and either established or negatived. The history of science has constantly shown that small residual effects *may* contain the germ of important discoveries. I hope that it may turn out so in the present instance, though I cannot say that I hope it with any confidence.

OLIVER LODGE.

Photograms of Auroræ in Southern Norway.

SINCE 1911 photograms of aurora have been taken systematically from my stations in southern Norway, and many hundred photograms and ordinary photographs have been measured and calculated in order to find the height and situation of aurora in space. A detailed report of the results from 1911 to 1922 has recently been presented to the Academy of Science in Oslo, and it is to be hoped that the publication will not be very long delayed. During the years 1923, 1924, 1925, and 1926 the work has been continued, with six stations at work, and more than 250 successful photograms have been taken, and several hundred photographs. This material, which has not yet been completely measured and calculated, will be a very valuable supplement to that mentioned above.

Especially this spring, during the splendid auroras of January 26 and March 5 and 9, a long series of interesting photograms has been taken. On January 26 I first saw the aurora from my house at Bygdø near Oslo, at 17 h. 40 m. Greenwich time, as a green-yellow arc under the Great Bear. Some minutes later a reddish to violet coloration appeared in the north-west, which had a quite diffuse character without visible rays. I took a series of photographs of it, and on the plates ***thin small rays are visible which could not be detected visually.***[1] (Plates Sonja E.-W., Herzog, Bremen.) About 18 h. 30 m. the aurora was splendid. Two arcs stretched over the heavens, from west to east; the northern was red and the southern was green. I am sorry to say that I did not get photograms of these arcs; visual observations from Denmark and from central Norway show that the red arc had an altitude much greater than the green one. About 19 h. the red arc had dissolved into long red rays which formed a beautiful corona. Of this I succeeded in taking a series of photographs which showed that the point of radiation had a somewhat abnormal situation: height above the horizon 72°, azimuth ÷3° to ÷4° (mean from 61 photographs during the period 1911 to 1922, are 70° and ÷9·7° respectively).

Soon afterwards the first period of activity ended, and it was not until about 21 h. that a new period of great activity began. The red coloration was sometimes exceedingly intense, in spite of the full moon, especially in the north-east. About 22 h. 30 m. the aurora was again quiet, but the third period of activity occurred about midnight to 1 h. in the morning, when the observations ceased. As the long series of photograms (about twenty) have not yet been calculated, we will content ourselves with this short report.

On February 24 the aurora appeared again with fine yellowish-green curtains at 18 h. 15 m. to 18 h. 50 m. in the north up to the polar star, and I saw the green aurora line in the zenith and to the south. But clouds all over the sky rendered photographic work impossible.

The next great aurora appeared on March 5. Long rays on the northern sky and in the zenith were observed already at 18 h. At 18 h. 30 m. I got into telephonic connexion between my station at Bygdø and my station at Tømte (48 km. to the N.N.W. of Bygdø), where the Antarctic explorer Carsten Borchgrevink took photographs simultaneously by instructions through the telephone. We succeeded in taking about 48 photograms, 30 of which were successful. One of these is reproduced in Figs. 1 and 2.

The measurements and calculation of this photogram showed that the altitude of the lower border was unusually high; four points at the feet of the rays gave the altitudes of 135, 132, 131, and 137 km. above the earth. The summits of the rays reached at least 350 km. Of this interesting curtain we took a series of photograms which showed that the lower border was continually descending and increasing in brilliancy, but the detailed computations have not yet been made.

The first period of activity ended about 20 h. 10 m. A new one began at about 21 h. 10 m. with a diffuse arc in the north. This grew successively stronger, and changed at about 21 h. 27 m. into rays and curtains which lasted until about 22 h. In the meantime the station in Kongsberg had been ready for work and five interesting photographs were taken simultaneously from the stations Bygdø, Tømte, and Kongsberg (mutual distances 48, 64, and 105 km.). Also my two stations Oslo and Oscarsborg were now in action and obtained five successful photograms. After 22 h. the aurora retired to the north and remained stationary as a low diffuse arc near the horizon.

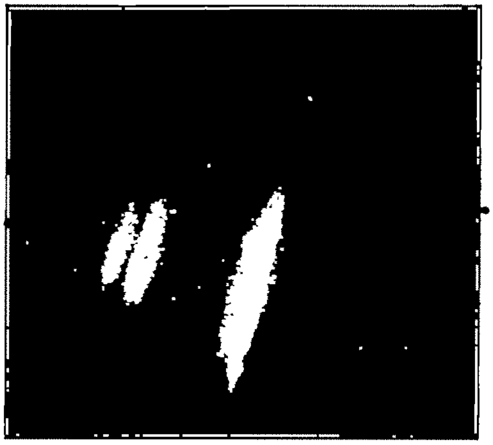

FIG. 1.—Auroral curtain, photographed at Bygdø at 18 h. 36 m. The stars γ, δ, ε, ζ and η of the Great Bear are seen very well on the picture.

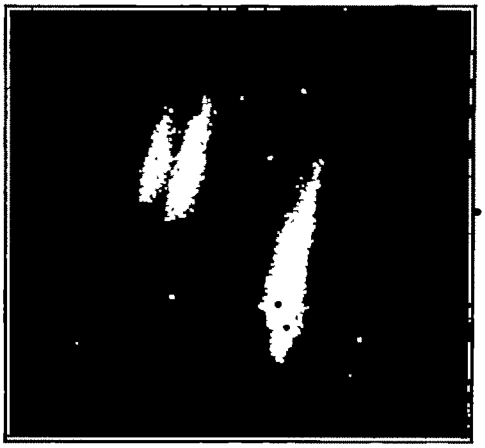

FIG. 2.—The same curtain photographed simultaneously by Carsten Borchgrevink at Tømte. Notice the great parallax referred to the same stars.

The third great aurora appeared on March 9. I am sorry that I was absent from my station during the maximum activity of the aurora. Nevertheless, some photographs of the corona were obtained, and a few photograms, none of which have yet been calculated. Other auroræ, but not so brilliant, were observed and photographed from my stations on February 10, 11,

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[1] I have seen an analogous phenomenon previously (see *Naturwissenschaften*, 1923, p. 338).

13, 23, on March 3, 10, 11, 12, 13, 14, 16, 19, 21, all on April 10, and on May 3.

In connexion with these phenomena, Mr. Boldermo in Hemnesberget, Ranen, Norway, has made an interesting observation. In a letter to me dated March 12 he says: "About three weeks ago I observed that the northern lights influenced my wireless set. I observed that every time the northern lights appeared against the zenith and on the southern heavens, there was heard a cracking noise in the telephones.[1] I uncoupled the antenna from the apparatus and the latter appeared to have static charges. Against earth these ran over to a distance of up to 15 mm. about three times a second. As soon as the northern lights decreased, the charge by degrees disappeared. The night was almost clear with a slight wind. I have observed the same phenomenon twice later on."

In a subsequent letter he gave me a drawing of his antenna, which shows that the top of it is about 12 metres above the ground. From this it seems that the aurora sometimes modifies enormously the potential gradient in the atmosphere, and this phenomenon should be verified by other observers.

CARL STØRMER.

Propagation of a Single Harmonic Wave in a Medium in which the Group Velocity and Wave Velocity are the same.

IT is, I believe, held by many physicists that it is impossible to initiate or transmit a single wave in which the displacement is a simple harmonic function of time and space throughout.

The object of this note is to show that, given certain initial conditions, single waves or finite trains of waves which from beginning to end are of the simple harmonic type can be initiated and will travel unchanged in form; and further that, with slightly modified conditions, fractional parts of such waves can also be propagated unchanged, and will travel with the same velocity as the complete wave of which they would form a part.

Consider first an infinite train of waves in which the displacement referred to the axis XX, Fig. 1, is

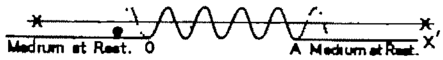

FIG. 1

given by $y = a \sin pa$, where a is the amplitude and $p = 2\pi/\lambda$.

At each maximum and minimum value of y the medium is at rest and the displacement velocity is zero. If the curve is referred to an axis OX′, touching the maxima or minima with the origin at O, the equation becomes $y' = a(1 - \cos px')$. At $x' = 0, \lambda, 2\lambda$, etc., the displacement velocity is 0, and the acceleration ap^2.

Now suppose (*a*) that all the waves except those included between O and A are removed and that the medium outside these limits is at rest. Then the conditions for the continued propagation of the remaining waves are fulfilled, for the velocities and accelerations within the series remain unchanged, and the terminal accelerations are supplied by the excess of pressure (proportional to a/λ) within the series over that in the medium outside, which is at rest.

(*b*) If it is required to propagate an odd number of half wave-lengths the medium on either side of the wave series must be at rest, but having pressures differing by a quantity proportional to $2a$/wave-length. When (*c*) fractional parts of a wave are to be propagated, not only must the pressures on either side of that part be different, but also the two parts of the medium separated by the wave must have a relative velocity, determined by the displacement velocities at the limits of the propagated fraction.

Case (*a*), where a single wave or a whole number of waves is under consideration, can easily be made the subject of experiment.

Let a tube of unlimited length and of any diameter (Fig. 2) be provided with a piston on which a harmonic motion can be imposed. Let the air in the tube be at rest and the piston at the position of maximum displacement. If now the piston is caused to make one complete oscillation and to return to rest at its original position, the result will be that a simple harmonic wave will travel along the tube from each side of the piston, and that in one of these waves (namely, that in which the air is at first compressed) the mean pressure will exceed the still air pressure by a quantity proportional to a/λ, while in the other there will be a defect of pressure of the like amount. A barrier, therefore, placed in the tube will experience an average force during the action of the wave in a direction away from or toward the piston, according as the initiation of the wave starts with an increase or decrease in the air pressure. If the barrier is such as completely to absorb the wave motion, the magnitude of the force will be measured by a/λ, or by $2a/\lambda$ if the wave is completely reflected.

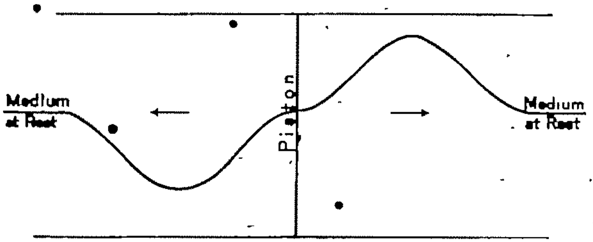

FIG. 2.

In cases (*b*) and (*c*), where an odd number of half wave-lengths or fractions of wave-length are concerned, it would be more troublesome to reproduce experimentally the required conditions. In the latter the motion is analogous to, though not identical with, the progress of a 'bore' in a river where the boundary between deep and shallow water travels as a wave with an accompanying change of stream velocity.

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Barlow's Tables.

REQUIRING recently the square roots of the numbers from 1 to 100 to ten figures, or one more place of decimals than is given in Barlow, I was led to the discovery that his last figure for numbers above 1250 is not to be depended upon for its accuracy. It is true that De Morgan, in issuing a reprint of Barlow's Tables in 1839, admitted that his method of checking Barlow's entries by differencing left "remaining a possibility of any of the last figures being a unit wrong in the columns of square and cube roots."

The purpose of this note is not to criticise a work that must ever remain a monument to the industry and zeal of an enthusiastic computer at a time when calculating machines were not in existence, but merely to place on record what must, I am afraid, be a very incomplete list of errata, all the more important because Barlow is a standard work, and the constant companion of the practical man. By the very nature of my original inquiry, I only examined one entry in each double page of Barlow, that is, one out of a hundred. These were 1300, 1400, 1500, etc. Out of 87 entries examined after 1250, 19 are wrong by one in the last place. A little further investigation, too, soon showed that in certain parts of the table the error is continued throughout a series of consecutive entries.

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[1] That noise was also heard by engineer Max Rich. Hennig in Ångermanland, Sweden, during the aurora on March 9.

The conclusion is irresistible that in no case throughout this portion of the table can the last figure of the square root be depended upon. Of course the average man feels very happy if he has the perseverance to push his results to five, six or even seven figures. But there are some who have need of all the figures that existing tables give them, who sometimes wish, indeed, that more were available. For such the warning conveyed by this note is intended. It is a matter for surprise that 5000, 7200, 7500 and 9800, in particular, are in error, since the figures of the roots are those of $\frac{1}{\sqrt{2}}$, $6\sqrt{2}$, $5\sqrt{3}$ and $7\sqrt{2}$ respectively, and $\sqrt{2}$ and $\sqrt{3}$ have long been known to a very large number of places. The list of errata is subjoined, the correct result being in each case given.

Number.	Square Root.	Number	Square Root.
1400	37·4165739	6100	78·1024968
2000	44·7213595+	6600	81·2403840
4300	65·5743852	6900	83·0662386
4697	68·5346628	7100	84·2614977
4698	68·5419580	7200	84·8528137
4699	68·5492524	7500	86·6025404
4700	68·5565460	7800	88·3176087
4701	68·5638389	8600	92·7361850−
4702	68·5711310	8700	93·2737905+
4703	68·5784223	9100	95·3939201
4704	68·5857128	9800	98·9949494
4705	68·5930026	9896	99·4786409
4998	70·6965346	9897	99·4836670
4999	70·7036067	9898	99·4886928
5000	70·7106781	9899	99·4937184
5001	70·7177488	9900	99·4987437
5600	74·8331477	9901	99·5037688
5700	75·4983444	9902	99·5087936

+ or − after final 5 or 50 means that the correct square root is greater or less than the result exhibited. Such a convention minimises the risk of error when the decimal is curtailed. JOHN WISHART.

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Can Portuguese Oysters be produced on English Oyster Beds by Artificial Fertilisation in the Sea?

DURING a visit to the Blackwater oyster beds in the summer of 1925, I had reason to open 100 Portuguese oysters (*Ostrea* (*Gryphæa*) *angulata*), and found them, as on previous occasions, practically all sexually mature. It occurred to me at the time to try an artificial fertilisation in the sea with the view of increasing the stock of oysters on the beds. As, however, the beds were private ones, it was thought inadvisable to take the risk without consulting the owners, and the opportunity of trying the experiment did not again arise. It has been recorded in NATURE (August 12, 1922, p. 213) that Portuguese oysters have spatted in the waters of the river Blackwater, Essex, on experimental shells put out for the definite purpose of catching young oysters, and also (*loc. cit.*) that artificial fertilisations of the Portuguese oyster can be easily made.

The experiment would not have suggested itself but for the fact that on English oyster beds the Portuguese oyster spawns naturally only rarely, due no doubt to the relatively low temperatures occurring normally in English waters compared with those found in south European waters where the Portuguese oyster reproduces very abundantly. Nevertheless, there is no doubt that shelled larvæ can easily be produced artificially at temperatures which occur on English beds, but it is doubtful whether these temperatures are ordinarily high enough to ensure fixation of the shelled larvæ when the latter are ready to settle. The success of the experiment will depend partly on the occurrence of suitable conditions for fixation of the larvæ in the year of the experiment—and high temperatures and clean shell for attachment are probably the critical factors concerned in the sea,—partly upon the production of sufficient larvæ to leave a balance for settling after the enemies of the larvæ have had their fling, and partly upon the larvæ being reared in a body of water which will not carry them away from suitable places of attachment.

As a provisional experiment it is suggested that a thousand Portuguese oysters be cut into rather thick shreds and shaken in the sea over the oyster beds at half tide at the beginning of the neap tides. From 60 to 90 per cent. of the oysters would be female (see *J.M.B.A.*, vol. 14, p. 230, 1926), and from each would be released in this way an *estimated* average of at least three million eggs for medium-sized oysters. A plentiful supply of sperm would be available from the smaller number of males. If a thousand oysters were disintegrated in the sea on five successive days, there would be a greater chance of sufficient larvæ being produced to give a spatfall, other conditions being favourable. The time most likely to be favourable for the experiment may be fixed in the neighbourhood of the end of June in a normal year.

The experiment itself is so simple that it could be carried out by the normal summer staff at work on an oyster bed, but practical difficulties, such as the attraction of shoals of fishes and other marine animals to the locality of the experiment, might have to be obviated.

The creeks bordering on the Thames Estuary, north and south, and creeks and estuaries on the southern coast, such as occur at Salcombe and the Fal (River and Upper Estuary), and no doubt elsewhere on this coast where this oyster is unknown, would be suitable places to attempt the experiment.

A warning is, however, needed: the Portuguese oyster may procreate on some southern beds so well as to oust the native European, and it is not so valuable. At Arcachon (France) the Portuguese oyster was accidentally introduced on the fine beds of European oysters there and was regarded for decades as a pest, though at the present moment it is the salvation of many oyster-cultivators in that region.

I should be willing to give further suggestions on the method of carrying out the experiment to any oyster-producer who may desire to try the experiment.

J. H. ORTON.

The Laboratory,
The Hoe, Plymouth,
June 7.

Capture of Electrons by α-Particles in Hydrogen.

The phenomenon discovered by Henderson (*Proc. Roy. Soc*, 102, 496, 1922) of the capture of electrons by α-particles passing through matter has attracted much interest and has been subjected to theoretical investigation from various sides By comparing the statistical equilibrium between capture and loss of electrons by α-particles with an equilibrium of thermal dissociation, Fowler (*Phil. Mag.* 47, 416, 1924) was able to account for many of the characteristic features of the phenomenon revealed by Rutherford's careful examination (*Phil. Mag* 47, 277, 1924), in particular, for the fact that the ratio between the probabilities of capture and loss for α-particles of given velocity was nearly the same in all substances investigated and varied approximately as the fifth power of the velocity.

As pointed out by Bohr (*Zs. fur Phys.*, 34, 142, 1925), this theoretical argument involves difficulties when applied to substances of small atomic number in which the interatomic velocities of the electrons are all small compared with that of the α-particles Recently Mr. Thomas, working in this Institute, has examined this point more closely; his calculations suggest that the ratio between the probabilities of capture and loss in such light substances should vary as a much higher power of the velocity than that holding for the heavier substances examined by Rutherford, and that for high-speed α-particles this ratio should be much smaller for the light substances than that observed for the heavier substances

At the suggestion of Prof. Bohr, the writer undertook an experimental investigation in order to test these results. The apparatus was of the same type as that used by Rutherford to examine the capture and loss of electrons by α-particles in gases. In this method the beam of α-rays passing into a vacuum through a mica window is deflected by a magnetic field. The distribution of the scintillations then shows two distinct peaks corresponding to singly- and doubly-charged α-particles. If now gas is let into the deflexion chamber, this distribution is changed on account of the loss and capture of electrons by the α-particles when passing through the gas.

On increasing the pressure of the gas the peak corresponding to the singly-charged particles gradually disappears and there is established between the two peaks a continuous distribution of scintillations due to particles which have either lost or captured an electron during the passage through the gas When the pressure was so adjusted that the number of singly-charged particles had decreased in a given ratio, it was found that the continuous distribution in air was essentially different from that in hydrogen, the density of scintillations for any given deflexion in air being more than double that in hydrogen. This shows that the probability of capture is considerably larger in air than in hydrogen in circumstances in which the probability of loss is the same

This conclusion was confirmed by a closer examination of the continuous distribution of scintillations in air and hydrogen at different pressures. While in air a considerable part of this distribution had to be ascribed to capture, it was found that the distribution in hydrogen could be accounted for within experimental error on the assumption that it resulted solely from the loss of electrons by the α-particles In close agreement with Rutherford's measurements, the mean free paths for capture and loss in air (reduced to normal pressure and temperature) were found to be 2·1 mm and $1{\cdot}0 \times 10^{-2}$ mm respectively. The velocity of the α-particles was $1\ 75 \times 10^{9}$ cm. per sec At this velocity the mean free path for loss in hydrogen was found to be $7{\cdot}8 \times 10^{-2}$ mm., in satisfactory agreement with ionisation theory As a lower limit for the mean free path for capture in hydrogen the experiments gave 200 mm. Although the probability of capture in hydrogen predicted by theory corresponds to a still longer mean free path, the experiments seem to afford suggestive support for the theoretical considerations.

J C Jacobsen.

Universitetets Institut for teoretisk Fysik,
Copenhagen, May 17

Birth of Peripatus in England.

A record of the birth of living Peripatus in England is perhaps worthy of note, especially since the case is probably unique. At least it serves to show how a creature which is particularly susceptible to its environment may be carried very long distances overseas and kept in captivity. The present case is all the more striking because only a single animal was brought from Australia; it is not, therefore, one survivor out of many.

During 1925 one of us (Miss Fordham) visited Western Australia for the purpose of collecting certain zoological material for research Amongst other items in the programme it was intended to collect a number of Peripatus late in the season (the animals disappear at the beginning of the dry season in Western Australia—say, October or November). Unfortunately the wet season was remarkably dry last year and extremely few Peripatus were to be found. Only one living Peripatus commenced the voyage from Australia to Europe, and this was captured on September 20. At this time of the year fertilised females may be found.

Contrary to our expectations, the specimen survived the ocean voyage and continued living at Liverpool, where it arrived in January. The animal turned out to be a female, and during the month of April, six months after its capture and at least five months after contact with other Peripatus and four months after leaving Australia, gave birth to young of which two are actually living now with the mother (May 18)

The specimen is kept on its native soil in a large glass museum jar with glass stopper. It has pieces of bark for shelter, and it is given bits of woodlice, which apparently it does not eat. A few termites were present in the soil and there are numbers of Protura.

It is thus quite clear that the Western Australian Peripatus receives spermatozoa during the wet season (winter), and that the period of gestation is upwards of six months, when normally the animals are hidden away within rotting wood or below the soil during the dry season.

William J. Dakin.
M G. C. Fordham.

Zoology Department, University,
Liverpool, May 18.

The Sensitivity of Selenium Cells.

The selenium cell, as a light-sensitive element, has always been held to have the inherent drawbacks of inertia and lag, and therefore to respond too sluggishly to changes in light intensity, and to return to its normal low conductivity much too slowly when the illumination to which it has been subjected is cut off. Several forms of photometer are now in use in which selenium or photo-electric cells are employed, and were selenium more certain and more prompt in action it would offer certain advantages over the photo-electric cell.

A. Korn did much to increase the utility of selenium by simultaneously subjecting two cells of different sensitivity to the source of light, using them on opposite arms of a Wheatstone bridge arrangement. He found that for an increase of illumination δI, the current y obtained for a given voltage passed through the cell was $\alpha\delta I e^{-\beta t^{-1/m}}$, where β is an inertia constant, and m the 'exponential inertia'; m should be as much below 1 in value as possible and depends on the mode of preparation of the cell.

By selecting two cells such that

$$\frac{d(y_1 - y_2)}{dt} = 0$$

where y_1 and y_2 are respectively the small increments in conductivity for an illumination of time dt—which means that the product $\alpha\beta$ of each cell is practically the same — wonderfully sharpened action can be obtained which should be of the greatest value if it were applied to photometric work

I have recently tried passing a single-phase alternating current through a Kipp and Zonen selenium cell, and, as I anticipated, the lag is automatically eliminated at each alternation of current, with the result that the cell responds with great celerity to changes in illumination and returns to zero—*i.e.*, its 'dark conductivity'—with great swiftness. The cell returns to the same zero time after time after quickly repeated illumination, very unlike its ordinary behaviour when the conductivity in the dark creeps up each time the illumination is cut off through cumulative ionisation. The periodicity of the current must of course be greater than that of the changes in light intensity.

It is quite easy to rectify the current that is passed through the cell so that an ordinary galvanometer can be used. The experiments indicate that by using alternating current an entirely new field of possibility is opened up for the selenium cell. Some years ago, when reproducing records of the voice on kinematograph film with selenium, I found that so many as 8000 vibrations per second could be dealt with distinctly, which indicates that our conception of the rate with which selenium can respond to changes in light intensity has been greatly handicapped. By the employment of alternating current, and so accelerating its rate of change, we may find that the selenium cell is of an extremely high order of sensitivity

T. Thorne Baker

Research Department,
Imperial Dry Plate Co., Ltd.,
Cricklewood.

Magnetic Properties of Single Crystals of Iron.

In a letter to Nature, May 29, p. 753, Messrs. Honda, Kaya and Masuyama give a short account of some magnetic properties of single crystals of iron. In this laboratory I have investigated various magnetic phenomena in single crystals. In the *Proc Roy Soc.*, 107, 496, 1925, an account of the variation of the susceptibility with the direction in the crystal has been given, and it may be mentioned that later a theoretical explanation of the effect has been given by Mahajani (*Camb. Phil. Soc.*, 23, 136, 1926) In the *Proc. Roy. Soc.*, 109, 570, 1925, experiments on the effect of crystal structure on magnetostriction have been described. This work is similar to that now described by Honda, Kaya and Masuyama, and their results are in very good agreement with those of the present writer. The rods used by them were much larger than those of our experiments, and their accuracy may be higher, particularly in the measurement of the magnetic intensity, but our results are more definite in that the rods used by us were orientated, within two or three degrees, parallel to a (100), (110), or (111) crystal axis For example, we showed definitely that for the (111) direction there was only a contraction, a fact surmised by Honda, Kaya and Masuyama.

We hope to publish shortly some work already completed, on the change of resistance of iron-crystal rods in a longitudinal magnetic field. The results of this work have an important bearing on the phenomenon of magneto-striction, as they indicate that the increase in length for the (100) axis is quite different in origin from the decrease in the (111) direction.

W. L. Webster.

Trinity College,
Cambridge.

The Taxation of Research.

We have received notification that the Inland Revenue authorities are about to challenge the right of the Chemical Society as a charitable institution to recover the income tax deducted at the source from the interest on its invested capital. For eighty years the Society has published freely new knowledge in chemistry, and has carried a financial burden which could not have been borne had not Governments in the past provided rent-free accommodation and relieved the Society from taxation.

The great increase which has taken place, and is still taking place, in the amount of research work in chemistry emanating from our universities and university institutions renders it difficult, even under present conditions, for the Society to carry out the duties assigned to it by its charter, in view of the fact that within the past seven years its expenditure has increased by some 7000*l.* a year.

The margin between solvency and bankruptcy is small and may disappear if the Society is subjected to the taxation suggested.

H. B. Baker, President
Jocelyn Thorpe, Treasurer.

Royal College of Science,
South Kensington,
London, S.W.7,
June 8.

The Coal Fire.

It is the opinion of every one with whom I have spoken on the matter, that a coal fire possesses some subtle qualities which a gas or electric fire lacks. In her letter to Nature, March 6, p. 343, Dr Stopes instances the great curative powers of a glowing coal fire, and the renewed vitality she experienced after exposure to it during convalescence. My own experience with chickens has a direct bearing on the subject.

A number of chickens hatched during April, and housed in dry quarters well heated by oil lamps, round which they could cluster, appeared to be in a half-dying condition and looked exceedingly unhappy. On being placed before a bright coal fire, recovery was rapid, and they became so lively in an hour or so that they were often difficult to recapture.

Contrary to the experience of Prof Hill with animals (Nature, April 3, p. 487), close up electric lamps apparently do not exert a similar beneficial influence on chickens. A visit to any establishment in this city where these birds depend on electric lamps for warmth and in part for light will bear this out.

J. D. Fulton

The University,
Glasgow.

The Relationship of Physics to Aeronautical Research.[1]

By H. E. WIMPERIS, Director of Scientific Research, Air Ministry.

AVIATION is now entering upon a new and intensely interesting phase—one which will call for every scientific resource at our command. The materials of construction are changing: wood is giving place to metal. The engine proves to have most unexpected possibilities ahead of it through the increase of intake pressure; whilst the very lifting structure itself may possibly change, for some purposes at least, from linear motion to rotary. Now in aeronautical work there can be no doubt that scientific studies have been considerably stimulated by problems which have arisen directly from aeronautical engineering. The thought of those physicists who have in recent years done such brilliant work on the mathematical theory of fluid motion was stimulated in no small degree by the results obtained either in the wind channels of our aerodynamic laboratories or in free flight on the full scale.

Aeronautics by its youth escaped the medievalism of the old-time practical engineer; it was launched well in the modern scientific path by the formation some seventeen years ago of the Advisory Committee for Aeronautics, which after two phases of re-adjustment is still with us as the Aeronautical Research Committee. When I first knew it, it was presided over by that kindly and gracious being the late Lord Rayleigh; in those days the field of work was small enough for all matters to be dealt with by the single Committee. Now the scale is so much greater that many sub-committees and panels have to share its responsibilities. The latest phase is the organisation under the Air Ministry of a separate scientific research department to ensure that scientific investigations shall receive their due, and be vigilantly guarded against any competition for money, staff or facilities by the seemingly urgent claims coming from other quarters.

The scientific research staff of the Air Ministry closely resembles the corresponding staff at the National Physical Laboratory in its method of recruiting, its scales of pay, and its conditions of work. This staff is about eighty in number, and of this general 'pool' some four-fifths work in the laboratories at Farnborough and the rest at such stations as Martlesham, where the performance of new airplanes is studied, Felixstowe, where corresponding work is done for seaplanes, and the Air Ministry Laboratory in the Imperial College of Science, where special problems, mainly physical and chemical, are studied.

The examination of the flow around aerofoils and of the fluid forces brought into play has naturally formed one of the chief items of physical research in the wind channels of the aerodynamic laboratories throughout the world. The simpler measurements usually made on aerofoils are the lift and drag coefficients and the motion of the centre of pressure. These, the ordinary methods of classical hydrodynamics, are not capable of predicting from theoretical considerations alone, since the mathematics deal only with the motion of a fluid in which viscosity plays no part.

In the case of a simple mathematical shape, such as a cylinder placed at right angles to the flow, the positions of the streamlines, as determined for an inviscid fluid, differ appreciably from those which would arise in a viscous medium such as air. In the former fluid, moreover, no resultant force acts upon the cylinder, whereas measurements made in an air channel show that considerable forces are brought into play. Indeed, without such forces flying would not be possible.

If now to the streaming of the inviscid fluid past the cylinder there be arbitrarily added a 'circulation' of the fluid around the cylinder, there at once comes into existence a resultant force at right angles to the stream. This has an immediate analogy with the lift force experienced by an aerofoil, and with the propulsive force produced by the action of the wind on the rotating cylinder of the Flettner rotor ship.

It is seen, therefore, that by the addition of the idea of a 'circulation' around the body, a possible explanation is given for the existence of lift forces, and in recent years, by the employment of this convention, successful efforts have been made actually to predict the lift of certain forms of wing section. Naturally, a theory such as this has had to face much criticism, but some years of experience with it have enabled comparisons to be made with data obtained in the laboratory, and such comparisons have shown that it affords a close approximation to what actually happens. The theory itself was built upon the work of many investigators, and among that many I would like specially to refer to the work of Lanchester, Joukowsky and Prandtl. As a result of the work of these and other pioneers, therefore, we find it useful in aerofoil design to study the effect of imposing upon the motion of an inviscid fluid a 'circulation,' of unknown origin, around the aerofoil of sufficient amount to carry what is known as the 'stagnation point' to the trailing edge of the wing. 'Circulation' must have a physical existence, since the velocity is greater above the wing than it is below, though this real circulation is a circulation with no slip, whereas the mathematical circulation has slip. Hence the rather amusing situation arises of adding to the mathematical study of streamlines a conventional motion which could not really arise in an inviscid fluid! So long, however, as the limitations to the theory are borne in mind no harm can be done, whilst the results of such mathematical work are of the greatest utility as a first approximation as to what is happening.

One great merit of Prandtl's work is that his theory enables the lift of a wing of limited span to be deduced from the known performance of a wing of the same cross-section but of unlimited span; in other words, that the results of three-dimensional flow can be deduced from the known two-dimensional. The two-dimensional flow can be studied in two ways: experimentally, by means of a model wing-section stretching right across the wind channel; and mathematically, by the method initiated by Joukowsky, who found a way of predicting these forces by the mathematical step of converting a circle into the desired aerofoil shape by means of a suitable conformal transformation. For a limited number of aerofoil shapes it is therefore possible to deduce theoretically the performance for two-dimensional flow, whilst by the Prandtl theory it is possible to convert these results from two-dimensional to three-dimensional conditions. This work has been put to use by the Air Ministry scientific research staff, and some six aerofoil sections have been designed on this basis with the object of obtaining in the first instance a good thick wing, and in the second, a good racing wing. This theoretical work has been fully confirmed by subsequent experimental results on such aerofoils, whilst on certain of these wings full-scale work in free flight has been put in hand.

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[1] From a lecture delivered before the Institute of Physics, at the Royal College of Science, South Kensington, on June 7.

Many attempts have been made to build a type of aircraft known as a helicopter, which is fitted with rotating wings driven by one or more engines. Little success has, however, been met with in spite of considerable expenditure. But in the last year or two, real success has been achieved by Señor de la Cierva with his 'autogiro'; this machine is not strictly a helicopter, however, since the windmill is not power driven. But I think there is little doubt that it is through the autogiro, or, in English, the gyroplane, that we have the best means of studying the performance of all rotating wing machines. One of the difficulties with a rotating wing is that the part which is moving in the direction of flight has a higher airspeed than the retiring part, and this leads to greater lift on one side of the machine than the other. Mechanisms to balance these forces mechanically are most complicated to build and still more complicated to control. Cierva cut the knot of this difficulty by hinging his blades close up to the vertical shaft. This meant that the advancing blade merely lifted a little above its average position while the retiring blade fell a little below that level; thus the wings oscillated in a vertical plane during each rotation and presented some analogy to the flapping flight of birds. Centrifugal force prevents the wings from folding up about their hinges.

Owing to wall interference in the wind-channel tests that have previously been made on such windmills, or for some other reason, their capacity for slow descent under load was underestimated. This underestimate was first realised as a result of the tests carried out at Farnborough last summer with a Cierva gyroplane in which the vertical velocity was some 15 feet per second only, about half the speed of fall of a parachute carrying the same load and having a diameter equal to that of the windmill.

Full-scale tests on aircraft components usually require a greater space than can be given in a laboratory, and in consequence the physical investigations arising therefrom need to be carried out through the medium of models. It is no difficult matter to make an accurate scale model of any form of aircraft, and to provide a wind channel of such dimensions as will make the test reasonably representative. That is relatively simple, but a difficulty soon arises through what is known as 'scale effect.' The study of scale effect is intricate and much work has yet to be done. But it has been proved that model tests in the wind channel would represent what happens on the full scale if a certain physical ratio were preserved; this ratio is the product of length by velocity and divided by the kinematic coefficient of viscosity. This ratio is a non-dimensional one and it is coming to be known as the 'Reynolds' Number.' Model tests in wind channels as we at present know them give a value of the Reynolds' Number of but one-tenth of that appropriate to full scale. This is unfortunate, since it means that within the range of velocities available in the ordinary wind channel only a very small portion of the correction for the change of the characteristic under measurement with the Reynolds' Number can be studied: hence to deduce full-scale results from wind-channel experiments may mean extrapolation in the ratio of something like 10 : 1.

A limit to the air velocity in the channel is imposed by the considerable increase of horse-power for such operation; there is also an obvious limit to the dimensions of channels, and it follows that the only opportunity of obtaining a Reynolds' Number comparable with that applicable to full-scale conditions is by means of an increase in density of the air, or else of its replacement by some fluid having a higher specific gravity. Much interest has been taken in the pressure channel recently built at Washington, which is capable of being operated at an internal pressure of 20 atmospheres, so realising a Reynolds' Number equal to that of full-scale work, when allowance is made for the fact that a pressure tunnel is best run at about half the airspeed of an atmospheric tunnel, so that the amount of the forces acting upon the model may be kept within bounds. It is too early to say whether this channel has entirely fulfilled its constructors' hopes, but from such tests as have been reported it seems that the method of testing rendered possible by its use will prove to be of great utility.

Another form of model-testing is that carried out in the Yarrow tank at the National Physical Laboratory. This tank was originally built for the testing of ship models, but in recent years it has also been used for work on models of seaplanes. Investigations of this sort become specially necessary when the seaworthy characteristics of seaplanes need study. These craft have to be designed in relationship not only to their performance as flying machines, but also as to their habits when travelling on the surface of the water before they become entirely air-borne. For the aerodynamic characteristics the wind channel suffices, but for the study of the period prior to flight the tank is necessary. When considering the size and speed of a tank for this purpose one is faced with the consideration that the model must run at what naval architects term the 'corresponding speed' to that of the full-scale machine; speeds are said to be corresponding when the ratio of the velocity to the square root of the length of the model is equal to the velocity of the ship divided by the square root of its length. This ratio, it will be seen, is quite different from the Reynolds' Number above mentioned and it leads to totally different design requirements.

It might be thought from what has been said that the main purpose of the tank is to make accurate quantitative measurements. This, however, is not the case, since probably the chief use of such tests is a qualitative examination of the wave motion created by the hull, particularly in relationship to the position in which the engines and propellers are proposed to be placed.

The physical problems presented by the aero engine are for the most part not peculiar to aeronautics, but are part of the general study of the internal combustion engine. The use of this type of prime mover for aircraft does, however, present special problems owing to the urgent demand for 'reliability' on one hand and lightness on the other. Moreover, there is always the tenuity of the air at altitude to be reckoned with.

As a matter of fact, the aero engine has improved enormously in recent years—not so much perhaps as the result of scientific study as by sheer hard efficient work on the part of the engineering staffs of the engine-builders. As witness to this remarkable success, I would specially mention the performance of the Napier water-cooled engine on the flight to South America, the excellent behaviour of the air-cooled Jaguar engine on Mr. Cobham's flight to South Africa and back, and by no means least, the remarkable achievement of an air-cooled Jupiter engine in flying 25,000 miles without any overhaul.

Need for lightness of construction brings in quite other considerations. For high output, high efficiency is necessary, and this calls for increased compression pressures and a consequent liability to the troubles induced by detonation. The study of detonation and the means of avoiding it are fitting studies for physicists. Equally fitting are the investigations necessary to ascertain whether the output of the engine in relation to its weight can be increased by what is known as supercharging, and if so, how far in that direction it is expedient to go. All the while it has to be borne in mind that the engine must not only be capable of operating in a normal atmosphere such as that in which most internal-combustion engines work, but also in conditions in which the pressure may be only one-third of that at sea level and in which the atmospheric temperature may be no less than 50° Centigrade below zero.

This sensitivity of the engine to atmospheric pressure has led naturally to attempts to create an artificial atmosphere of increased density in the engine intake. A scheme of this sort was indeed mooted by Sir Dugald Clerk more than twenty years ago, and was called by him 'super-compression.' It is now known as 'supercharging' when the effort is to maintain an intake pressure at all altitudes equal to that at ground level, or 'boosting' when the effort is to increase the intake pressure by a constant fraction at all heights. These developments present an infinitude of problems most of which are now beginning to be seriously tackled—their close relationship to detonation is a complicating phenomenon. There are such great possibilities in this direction that a material decrease in weight per horse-power at altitude may confidently be looked for in the not distant future.

We live in a wonderful age. Just as in the thirteenth century the splendour of life must have seemed most to surround the work of the architect, or in the fifteenth century that of the painter, so it appears to me in the present age does it crown the labour and achievement of the physicist.

Iron in Antiquity.[1]

By Dr. J. Newton Friend.

It would be difficult to find a subject of greater interest than the study of iron in antiquity. Man's first acquaintance with the metal undoubtedly dates back, in certain districts, to the Stone Age. At that time meteoric iron would be much more common than now, and primitive man would soon observe that the metal was more malleable than ordinary stone, and could be cold worked, by repeated hammering, into simple shapes for ornament or for personal use. Probably this was the origin of the metal beads, the oxidised remains of which have been found in predynastic tombs in Egypt, dating back to about 4000 B.C. But it was not until man had progressed slowly upwards through ages of unremitting toil that he learned of the connexion between metallic iron and certain of the stones around him, and succeeded in reducing the metal from its ores.

Iron appears to have been manufactured in the Near East at a fairly early date. The Hittites were beginning to use iron weapons for military purposes about 1300 B.C., and Rameses II., King of Egypt, is known to have applied to the Hittite king for a supply of the metal. Whether he obtained it or not is unknown, but a mutilated letter has been found, possibly addressed to Rameses II., in which the Hittite king states that he is sending an iron dagger, and promises to forward a supply of iron

The Philistines are believed to have introduced the general use of iron into Palestine, although the metal was known many years prior to that. It is clear from references in the Old Testament (see 1 Sam. xiii. 19-22) that the Philistines retained the monopoly of working iron, with the result that at first there was no smith in Israel, and the only Hebrew persons possessing iron swords were Saul and Jonathan. In other words, the Philistines had already entered upon their iron age when the Israelites were still in their bronze age. By the time that David ascended the throne, however, the use of iron was becoming more general. Nevertheless, it is interesting to note that no iron tool was allowed to be used in the construction of Solomon's temple at Jerusalem. The employment of iron would have been offensive to God, who had in previous years spoken against the use of metal, and had ordered (Ex. xx. 25) any altars erected to Him to be made of unhewn stone. In view of this the following tradition is interesting. Whilst the present writer was in Jerusalem last year, his dragoman informed him of a curious belief prevalent amongst the Jews to the effect that if the crevices in the ancient wall at the famous Wailing Place are completely filled with iron nails, Jerusalem will once again be restored to the Jews.

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[1] Substance of a lecture delivered at the Royal Institution on June 5

The Greeks and the Cretans would appear to have been the first European peoples to use iron. Homer, who lived about 880 B.C., was very familiar with the metal. The Homeric age, however, as depicted in the "Iliad" and "Odyssey," is several centuries earlier; the Phaeaceans referred to in the latter work are believed to have been the Minoans of Crete, famous for their sea power—the Britons of the Mediterranean. The Homeric period was transitional between the Bronze and the Iron Ages. Iron was listed amongst the treasures of the wealthy, but was in general use only in the peaceful pursuits of agriculture. Probably the metal lacked homogeneity and could not be relied upon in such thin strips as would be necessary for swords, owing to its tendency to bend or snap. The Vikings 2000 years later were familiar with this difficulty, as is evident from the Icelandic sagas. One frequently reads that the swords would not "bite," and occasionally we are told that the sword bent so seriously that the warrior often had to straighten it under his foot! This surely was giving his opponent too much of an advantage.

The Romans about 2000 years ago were skilled metallurgists. Virgil in his "Aeneid," written about 40 B.C., describes a smithy in full work, and refers to the steel hissing as it is quenched in water, showing that the art of tempering was practised. Pliny some years later showed a wide knowledge of the ores of iron and of the working of the metal. He appears also to record, in what is otherwise an obscure passage, the accidental production of cast iron For this product, however, there was at the time no practical use, as the Roman furnaces were incapable of dealing with it. The tendency of iron to rust was regarded by Pliny as Nature's punishment on the metal which, owing to its use in warfare, "brings the greatest dangers upon perishable mortality." Occasionally, as now, the rusting of iron was turned to good account. A very clever metallurgical conception was attributed by Pliny to Aristonidas, who, wishing to express in a statue at Rhodes the "fury of Athamus subsiding into repentance after he had thrown his son Learchus from the rock, blended copper and iron, in order that the blush of shame might be more exactly expressed by the rust of the iron making its appearance through the shining substance of the copper."

Iron was regarded as symbolical of Mars, the god of war, and the alchemists represented it by the symbol ♂, which is usually supposed to be derived from the shield and spear of that god The popular idea that iron is a useful remedy and invigorates the constitution owes its origin largely to this connexion with the virile god, who was supposed to transmit his strength to his dedicatee. Ancient legend has it that King Iphiclus of Phylacea about 1380 B.C was very anxious to beget children, and was successfully treated by the shepherd Melampus, who dosed him with iron rust in wine—the earliest *vinum ferri* of the pharmacist on record!

Iron was known to the Britons long before the advent of Julius Cæsar. The Romans greatly extended its use in Britain, and numerous objects of iron are continually being unearthed on the sites of various ancient Roman stations. One of the most interesting of these is an iron ring, probably the remains of a ferrule, found last year at Uriconium. It appears to have been made by bending a strip of iron into a circle and soldering the ends together with some copper alloy. This is the first recorded example of such work.

Cast iron was known in Sussex by 1350 A.D. and soon became quite a familiar commodity. It was at first used exclusively for casting purposes. In 1516 a cast-iron gun weighing nearly 5 tons was made, and in 1588 the Spaniards armed their Armada with cast-iron guns as well as with the more familiar bronze weapons.

When, many years later, it was found that cast iron was the most suitable starting-point for the manufacture of iron and steel, the demand for it increased rapidly. In 1800 the United Kingdom produced about ¼ million tons of pig iron, a quantity that in 1913 had increased to a maximum of more than 10 million tons. In 1925 it had fallen to little more than 6 million tons—the aftermath of the War.

Structural Features of the Earth.[1]

ARGAND'S distinguished services in unravelling the structure and history of the Pennine Alps, and of the Alps in general, ensure a respectful hearing for his present wider venture Wide it undoubtedly is, for its seemingly ample title, "La tectonique de l'Asie," in no way contains it. Asia furnishes the text, the subject is Suess's own, the face of the earth.

It is interesting to find de Margerie, who did so much to secure recognition for Suess's masterpiece, acting as godfather to the new arrival. Argand explains that the basis of his memoir is a manuscript map, of which he prepared a first draft in 1912. The following year, de Margerie introduced this map to the notice of the Canadian meeting of the International Geological Congress, and since then has done all in his power to secure its publication. The Belgian meeting, 1922, promised us the map. The memoir, at any rate, is in our hands. In acknowledging his debt to de Margerie, Argand admits that he could not have faced the task without the help of this 'prince de la bibliographie.' Where so much is given, it may seem churlish to grumble, but many a student will miss any attempt at a considered bibliography in connexion with Argand's memoir. Perhaps the author felt that, when one writes of the world, the catalogues of libraries are themselves the bibliography.

Argand considers that modern knowledge requires a modification and extension of Suess's achievement, not a reconstruction. He starts by adopting Bertrand's *time-definition* of mountain building, employing it in a somewhat elastic sense: the Caledonian Cycle of mountain-building belongs to Lower Palæozoic times; the Hercynian to Upper Palæozoic times; and the Alpine to Secondary, Tertiary, Quaternary, and Recent times.

The deformations produced by horizontal pressure acting during any particular cycle are of several different kinds. Argand employs the following classification—the particular examples quoted belong to the Alpine Cycle:

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[1] "La tectonique de l'Asie," *Compt rendus*, Congrès Géol Internat., Session XIII, 1922 Belgique, 1924. By E. Argand Pp. 171-372 (Contents, pp 363-372), Figs. 1-27

(1) Deformation of thick comparatively unconsolidated marine sediments. This gives rise to *coastal chains*, such as girdle the Pacific Ocean, and to *geosynclinal chains* (generally double), represented by the great series that reaches from the Himalayas, by way of Persia, Anatolia, and Greece, through the Carpathians and Alps, and so into Spain. The Indo-African-Eurasian geosynclinal series unites with the Asiatic coastal series in the Malay Archipelago.

(2) Continental deformations that affect the foundations and cover of continental areas. The foundations of a continent consist of sediments compacted by some early cycle of mountain building (along with batholithic intrusions). The cover is the veneer of relatively unconsolidated sediments locally deposited on the foundations in epicontinental seas, fresh-water lakes, etc. *Foundation folds*, or *plis de fond*, may reach from any depth up to the surface. Where cover exists, it may be bent along with the foundation, and so give rise to one type of *cover fold*. Another type is exemplified in the Jura mountains, where cover has parted company with foundation.

Argand attributes very great importance to foundation folds. Their existence can be detected in a variety of ways. In Scandinavia it is the *present* height of the mountain chain that betrays its Alpine date. The Alpine fold responsible for the elevation (or re-elevation) is of so great a radius of curvature that it escapes purely geological search—all the readable folding and thrusting in this district are admittedly Caledonian. In the Pyrenees, Caucasus and Thianshan, matters are easier for the geologist. These chains consist of groups of accentuated foundation folds that have broken into semi-rigid nappes, and have involved very considerable thicknesses of post-foundation cover. Many foundation folds, and these the more important, are a direct expression of the same push as makes the geosynclinal folds. Others, like the Mt. Blanc massif, have been produced indirectly through interaction with geosynclinal folds.

In his more definitely theoretical pages, Argand adopts Wegener's hypothesis of continental rafts of sial drifting upon sima. Geosynclines are intracontinental regions characterised by thick marine sedimentation. Their site is generally determined by a tendency for two parts of a continental complex to drift asunder. The connecting sial stretches, and as it stretches, its upper surface sags and thus provides a trough for the sea and its sediments, while its lower surface rises, followed by underlying sima. So long as the stretched connecting sial holds together, the subsidence is geosynclinal. Where the sial parts, the subsidence becomes oceanic. Eurasia and Indo-Africa have passed through long periods when they tended to drift apart. Such periods have seen the growth of the geosynclinal sea known to geologists as the Tethys, of which the Mediterranean is the latest recrudescence. During other periods, the two continental masses have tended to drift together, and have squeezed up geosynclinal mountains, that include the Himalayas of to-day as a supreme example.

One might continue this summary indefinitely, and discuss the making of the Mediterranean or the bow and stern phenomena of drifting continental rafts as exhibited along their oceanic margins. Space forbids. Let us merely recall the advice given to young Darwin preparing for his voyage on the *Beagle*. Lyell's "Principles" had just appeared. "Get the book," said orthodox old Henslow, "study it, but don't believe it." Argand has succeeded in correlating an enormous number of geological phenomena, and has thus given them a realisable unity. It may be wise, for the present, to consider his co-ordinating principles with a perfectly open mind; but this should not render us any the less grateful for the accomplishment of a singularly arduous and helpful piece of research.

E. B. BAILEY

Obituary.

SIR STEWART STOCKMAN.

IN the debate on foot-and-mouth disease in the House of Lords on Thursday, June 3, Lord Bledisloe, Parliamentary Secretary to the Ministry of Agriculture, said that Sir Stewart Stockman, Chief Veterinary Officer to the Ministry of Agriculture, had died on Wednesday in Scotland, and Sir William Leishman, chairman of the Foot-and-Mouth Disease Investigation Committee, had died in London. In both cases the Ministry had lost very able research workers and administrators, and the loss, so far as his department was concerned, was a very serious one.

Stockman's name will be readily connected with the drastic action taken in Great Britain during recent years, at enormous expenditure, in dealing with the menace of foot-and-mouth disease by the 'stamping out' process—a method of disease control obviously impracticable to the epidemiologist, but in certain circumstances the proper means of combat in the face of epizootic diseases. Although in its application crude, *primâ facie*, consisting in the wholesale slaughter of known infected and all possibly contaminated animals, the policy of 'stamping-out' as understood by epizoologists is the rationally correct mode of attack when no other system can be readily applied or is likely to be efficacious, and the cost of the process is estimated to fall most decidedly below the losses to the community that will most certainly occur without resort to the method. It is by the adoption of the 'stamping-out' system that the cattle population of England was effectively cleared of formidable scourges in the shape of cattle-plague (rinderpest) and contagious pleuropneumonia during the latter half of the last century, and the same method was applied to foot-and-mouth disease, with, when one compares the incidence of this disease in neighbouring continental countries, most salutary influence upon the live-stock industry of the country.

During this period the disease has reappeared from time to time, usually for some mysterious reason, among our herds, but has been dealt with consistently in the same manner. Within the last few years, however, the disease has made its appearance with disturbing frequency and spread often to an alarming extent before it could be coped with by the "stamping-out" process. The heavy responsibility of deciding upon adherence to the standard policy fell during this time upon Sir Stewart Stockman, in his technical capacity as Chief Veterinary Officer to the Ministry of Agriculture, and the amount of direct observation and estimation of the technical situation that devolved upon him must have told very heavily upon his physical strength, for he was never a robust man. It is in connexion with his clear-sightedness and determination in the face of problems in disease control of almost unprecedented economic gravity that scientific workers in this pursuit will in future years appraise Stockman as a man of exceptional merit, claiming a status in epizoology comparable to that of the greatest workers, such as Gorgas, in the field of epidemiology.

Born in 1869, the fourth son of the late Mr. W. J. Stockman, merchant, of Edinburgh and Leith, Sir Stewart Stockman was educated at the Edinburgh High School and received his professional training at the Royal (Dick) Veterinary College, Edinburgh, whence he qualified as member of the Royal College of Veterinary Surgeons in 1890. He then studied at the École Nationale Vétérinaire, Alfort, Paris, and afterwards occupied the posts successively of demonstrator of pathology and professor of pathology at the Royal (Dick) Veterinary College, Edinburgh. He resigned his teaching appointment in 1900 to serve in the South African War (where he contracted dysentery, which undermined his health in later years), and after the termination of the war accepted a post in the Indian Civil Veterinary Department, which had then just been thrown open to recruitment by civilian veterinary surgeons. His stay in India was brief, for he was appointed Principal Veterinary Officer to the Transvaal in 1902; but while in India he already showed promise of his capacities for dealing with epizootic disease; his work on rinderpest in that country was of high value. In South Africa he was confronted with most acute problems in epizoology, for the cattle population of the country had become exposed to the ravages of rinderpest since 1896, and new epizootics, in the form of East-coast fever and "red-water," had appeared, threatening the virtual ruin of the live-stock industry of the country. The dispositions taken by Stockman then to bring under control and eradicate these diseases and restore the live-stock industry to one of paramount importance in the economy of the country remain models of veterinary police organisation, and his researches in collaboration with Sir Arnold Theiler, then veterinary research officer to the Transvaal, exhibit his genius as an experimenter. His early training, therefore, first as a research assistant and teacher, serving a prolonged apprenticeship under such masters as McFadyean, in England (with whom he remained in lifelong collaboration), and Nocard, in France, and secondly, as an executive administrative officer in countries where epizootic disease plays an extraordinarily conspicuous rôle in the economy of their populations, fitted him peculiarly for the assumption of the specially arduous duties of his later years.

In 1905 Stockman was appointed Chief Veterinary Officer to the Board (now the Ministry) of Agriculture and Fisheries, to administer the Diseases of Animals Acts. His activities lay in two directions in this capacity—first, in the organisation and development of a field service, comprised entirely of qualified veterinary surgeons trained to deal promptly and efficaciously with epizootics, and secondly, in the foundation of a properly staffed research section, to carry out investigation work into the nature and proper methods of control of disease directly affecting the interests of the British agriculturist. He was admirably supported in developing the research activities of his department by the Right Hon. Walter Runciman while Minister of Agriculture, and a first-class laboratory—the first institute of its kind in Great Britain—was erected near Weybridge for research into the animal diseases. The laboratory has since been amply justified, both by the character and output of the researches from it, and among works published dealing with animal pathology, those upon "red-water," epizootic abortion, and other diseases of cattle, scrapie and louping-ill of sheep, swine fever, and certain diseases of poultry, deserve special mention, while the investigations now carried out there upon the nature of the foot-and-mouth disease virus are of a highly delicate technical order and aim at the solution of one of the most distressing factors besetting the valuable live-stock industry of Britain. Stockman's research work into animal disease, and in particular his researches into bovine epizootic abortion, performed largely in collaboration with Sir John McFadyean, have earned him an international reputation as a shrewd and careful observer and as a resourceful experimenter. He was appointed Director of Veterinary Research to the Ministry when the Laboratory was opened.

As mentioned above, however, it is as an epizoologist that Stockman must be meted the largest measure of distinction. He worked laboriously to mitigate the dangers of epizootic disease afflicting British live-stock, and succeeded, taking advantage of the insular situation of the country, to an extent wholly unknown elsewhere. Mention may be made of his efforts to suppress rabies, to eliminate glanders, to mitigate the ravages of swine fever, to control epizootic abortion, and bring about the gradually diminishing incidence of sheep-scab. The responsibility shouldered by him, practically alone, in the face of the recent incursions of foot-and-mouth disease, is well known, and the strain entailed must have told very heavily upon him. He had only just returned from a three months' tour to the Argentine, to investigate the conditions of the meat trade there with Great Britain, but was unable to resume his duties on his return. He had journeyed to Glasgow to consult his brother, Dr. Ralph Stockman, professor of materia medica and therapeutics in the University of Glasgow, about his health, and succumbed suddenly at his residence on June 2.

Stockman was joint editor of the *Journal of Comparative Pathology and Therapeutics*, a member of the council and president for the year 1924–25 of the Royal College of Veterinary Surgeons, a former member of the council of the Royal Society of Tropical Medicine and Hygiene, member of the managing committees of the Tropical Diseases Bureau and Imperial Bureau of Entomology, and a member of the Board of Governors of the Royal Veterinary College, London. He edited

Walley's "Meat Inspection." He was knighted in the New Year's honours list of 1913 for his services. By his conscientious and unassuming manner he inspired the confidence to an extraordinary degree of the Ministry he served, the veterinary profession, and the farming community of Great Britain. He married in 1908 Ethel, elder daughter of Sir John McFadyean, Principal of the Royal Veterinary College, London, and he is survived by her and two daughters, to whom we tender our deepest condolences in their sad loss.

WE regret to announce the following deaths:

Dr. Albert B Lyons, for many years a consulting chemist in Detroit, and formerly a member of the committee of revision of the "U.S. Pharmacopœia," on April 13, aged eighty-five years.

Sir Henry Morris, Bart., president in 1906–9 of the Royal College of Surgeons and in 1910–12 of the Royal College of Medicine, on June 14, aged eighty-two years.

Sir Frederick Walker Mott, K.B.E., F.R.S., formerly pathologist to the London County Asylums, on June 8, aged seventy-two years

News and Views.

THE letter from the president and treasurer of the Chemical Society, printed on p 859 of this issue, raises a question that is of considerable direct importance to learned societies in Great Britain and of no small moment to the cause of science. Hitherto the Inland Revenue has allowed the Society's claims for repayment of income-tax deducted at source, and now such claims are to be disputed. The grounds upon which the Inland Revenue is changing its attitude are not stated, but presumably it will contend that the societies in question (for other societies are also involved) are not described as "charitable institutions" in their charters, and, perhaps, also that they lose any right to this appellation by making profits from advertisements inserted in their publications. On the other side, the societies will rightly contend that they should not be classed with purely commercial undertakings; their work is not undertaken for pecuniary profit, and it is of educational nature and of national importance. Remembering Napoleon's gibe and the saying that "a country has the government it deserves," our national neglect of science is not surprising, but it would not have been so persistent if scientific organisations had learned to speak with one voice. Here is an excellent opportunity for united action, and if a test-case comes into court, it is to be hoped that the scientific societies will stand together, possibly under the leadership of the Royal Society, which is a "charitable institution" by the terms of its charter.

IN view of the difficult times through which the professional classes and the learned societies have been passing since the War, it is very regrettable that the Inland Revenue should now go out of its way to increase their hardships, and unless a strong stand is made we fear that some of the scientific societies will be severely hit by the new exactment. The statement made by Profs. Baker and Thorpe with reference to the Chemical Society that the "margin between solvency and bankruptcy is small, and may disappear if the Society is subjected to the taxation suggested," seems to require, however, some slight modification. According to its published accounts in the year 1925 the Society had more than 39,000*l.* invested in high-class securities, and it recovered 188*l* in respect of income-tax deducted at source. If the Inland Revenue were to claim tax on dividends from the 5 per cent War Loan, 1929/47, which are paid free of tax, the maximum total claim for income-tax (at 4*s.* in the *l.*) from the Society would be about 340*l.* Now the excess of income over expenditure in 1925 was 466*l.*, so that the question is one of a margin between a surplus and a deficit on a year's working, and not of a margin between solvency and bankruptcy. We point this out because we think that any semblance of overstatement should be avoided in prosecuting what is from every point of view (except, possibly, the legal one, upon which we express no opinion) a very strong case

IN the House of Commons on June 8, in Committee on the Finance Bill, a discussion took place on Clause 10 (Continuation and Amendment of Part I. of the Safeguarding of Industries Act 1921). This clause provides, among other things, for the continuance in force for a further period of ten years from August 19, 1926, of Part I. of the Act. The materials affected by the proposed duties are numerous—one speaker said that no fewer than six thousand separate articles were included in Part I. of the Act. The industries to be safeguarded in the way prescribed by the Act include the manufactures of optical glass, optical instruments and the component parts of optical instruments, as well as, for example, the manufactures of magnetos, fine chemicals and arc carbons. In the course of the debate some interesting statements were made by the President of the Board of Trade, Sir P. Cunliffe-Lister. Out of 37 motor manufacturing concerns in Great Britain only three were using British magnetos before the War, to-day all but three are using exclusively British magnetos It was also stated that Great Britain is producing something like 75 per cent. of our home consumption of fine chemicals, compared with 10 per cent. before the War. In respect to insulin, Great Britain has a very large share, not only of the home market, but also of the world market as well. To-day there are three or four times the number of skilled chemists employed in the British fine chemical industry compared with the number employed formerly, while the optical glass industry is now being developed (This is but a pale paraphrase of the tribute to the progress of that industry paid by Mr. F. Twyman in his presidential address to the British Optical Instrument Manufacturers' Association) Those responsible for equipping the Army, Navy and Air Forces have all said that their most minute requirements are met by the optical industry, and the industry has developed a new testing apparatus which is better than any apparatus developed in other countries. (This, presumably, refers to the camera lens and photographic lens interferometers of Messrs. Adam Hilger, Ltd)

THERE were the usual arguments advanced from the Protectionist and Free Trade sides respectively, arguments with the general character of which any student of politics for the past twenty years must be perfectly familiar. These political and fiscal considerations, as such, do not concern us here; but there are certain aspects of this question which touch nearly the interests of science and of scientific workers. In the first place, there seems to have been common agreement in the debate that there are certain industries which, from their character rather than from their size, are essentially key industries, that is to say, industries which, in the interests of the nation, both in peace and in war, cannot be allowed to languish and die, whatever fiscal system be regarded as best suited to the industries of the country as a whole. Whether the best method of safeguarding such essential industries be by a protectionist tariff, a direct subsidy, or a total prohibition of imports except under licence, is a matter of acute difference of opinion The optical industry in 1920, for example, expressed its preference for the last course. Taking the optical industry by way of example, the scientific worker has two main interests If there is not in Great Britain an efficient and progressive optical industry, in which there can be constant and close contact between the manufacturer and the scientific worker, the interests of the scientific worker and of science must suffer. If, on the other hand, the scientific worker is hindered, by tariffs or in other ways, in obtaining the materials and instruments he needs, or has to pay enhanced prices for them, again the interests of the scientific worker and of science must suffer, with inevitable injurious reactions upon the home industry itself. It should not be impossible to reconcile these apparently conflicting interests. But whatever be done, the primary and paramount duty of fostering scientific research, and more especially in any 'safeguarded' industry, remains. Safeguarding will be undoing if from a false sense of security it should lead to neglect of that most potent means of reviving a distressed industry, scientific research

APPARATUS has now been installed for transmitting photographs between London, New York and San Francisco. The journey from London is over the 220-mile land line to the Marconi radio-telegraphic station in Carnarvon, thence by radio-transmission across the Atlantic Ocean to the Riverhead Station of the Radio Corporation of America on Long Island, and afterwards by land lines. A description of the transmitting and receiving apparatus for the radiograms is given in the *Electrical Review* for June 4. The principles of the method of picture transmission over telegraph wires were clearly specified by Alexander Bain in 1842. Practically every system is based on the division of the picture into small unit areas and the transmission of the dots in these areas successively. When, however, it is remembered that the number of dots per square inch in an ordinary newspaper half-tone block is about 4000, it will be seen that the operation would be very laborious. To make it commercially feasible it has to be quickened up very considerably. At Radio House, London, the photograph or document to be transmitted is first copied photographically on to a transparent celluloid film mounted on a horizontal glass cylinder. A powerful beam of light is projected into this cylinder and then refracted out radially. The light passes through small areas of the film progressively, the intensity of the issuing beam depending on the transparency of the portion of the film it passes through. It then falls on a photo cell, the current from which is proportional to the intensity of the beam. The effects produced by this current after amplification are transmitted by the land wires and by radio-transmission to the photogram receiver. The received impulses actuate a siphon recorder mounted on a travelling carriage and operated by a motor controlled by a tuning fork. One of the main difficulties has been to obtain sufficient signal strength to over-ride the effects of atmospheric disturbances. It seems highly probable that the sending of photo-radiograms will soon be a recognised method of communication.

IN his discourse on "The Spectrum of the Aurora," delivered at the Royal Institution on June 11, Prof J. C. McLennan gave a short review of the knowledge of the constitution and state of the upper atmosphere We are gaining interesting information regarding the constitution of the atmosphere at great heights from investigations on the spectra of the auroral light From the work of Lord Rayleigh, Slipher of the Lowell Observatory, and Vegard, it is now known that the element responsible for a large proportion of the auroral spectrum is nitrogen. Vegard's view is that the well-known auroral green line originates in finely divided solid nitrogen in suspension, when bombarded by a corpuscular radiation from the sun. Prof McLennan's work on the spectrum of solidified nitrogen, however, shows that none of the spectral lines found in the spectrum of nitrogen in this state agrees in wave-length with the "green line," while the phosphorescent spectrum of solid nitrogen consists of eight distinct wave-lengths, none of which is included in the spectrum of the auroræ. Prof McLennan and his co-workers have observed a line at 5577 35 in the spectrum of oxygen when an electric discharge is passed through this gas, with helium present in excess. This spectral line possesses all the characteristics of the auroral green line, and it seems probable that both have their origin in oxygen. The line can be obtained with pure oxygen alone, but not with the same intensity as when helium is present. In seeking for the position of the wave-length 5577 35 in the spectral scheme of atomic oxygen, Prof McLennan and his co-workers have been able recently to show that the spectral system of oxygen consists of three sets of terms, one of which involves triplet and quintet terms, and the others singlet and triplet terms. The line 5577 35 belongs to one or other of the singlet-triplet systems, but it has not yet been assigned to any definite position From the observations on the spectrum of the auroral light it is clear that nitrogen and oxygen exist in the atmosphere at a height much greater than was supposed hitherto, while neither hydrogen nor helium appears to be present. While it is difficult to understand how this comes about, it may be that the forces, probably electrical, that maintain oxygen and nitrogen at the great heights mentioned is sufficient to draw away the hydrogen and the helium completely from the earth's atmosphere.

THE *North Western Naturalist*, a new quarterly journal, the first number of which has just appeared, is successor to the *Lancashire and Cheshire Naturalist.* Under its new title it appeals to a somewhat wider geographical and faunistic area in the hope that sufficient support will be forthcoming to justify the enterprise and to meet the undoubted needs of this important region. Several universities and many societies and associations devoted to the study of natural history and archæology are included in the area, and it is indeed surprising that past attempts to maintain a journal which would link up these various activities should have met with so little success. To judge from the contents of the first number, the scope of the journal is varied and wide. Mr H F. Barnes contributes a valuable paper on the crane-flies of Carnarvonshire, in which both the geographical distribution and ecology of the species are considered. Prof. Boycott records the occurrence of algal cysts in the tissues of *Limnæa peregra*, a hitherto undescribed association, the elucidation of which will be awaited with interest. News from the universities, local societies and museums, résumés of current periodical literature, book notices and reviews, and interesting notes and records, go to the make-up of an interesting number. The journal is attractively produced, and will be issued for the present in quarterly numbers at a subscription rate of 7*s* 6*d*. per annum. If the standard of this number can be maintained there should be no doubt of the success of the venture, and it is to be hoped that the editor, Mr. A. A. Dallman, will meet with that financial support which his enterprise deserves.

Popular Astronomy for May reproduces a short article distributed recently by Science Service—the scientific news agency of Washington, D.C., U.S.A.—in which it is stated that, according to information received from Leningrad, the 41-inch objective of the telescope being constructed at Newcastle-on-Tyne for the Simeis Observatory, in the Crimea, had failed to meet the optical tests specified and was absolutely useless. At the time when this report was received we sent a copy of it to Messrs. Sir Howard Grubb, Parsons and Co., and we are now informed that the statement is entirely erroneous. As a matter of fact, the degree of separation between the components of the object-glass and the radii of curvature were only officially agreed upon between the authorities at Polkovo and Sir Howard Grubb, Parsons and Co. at the end of April of this year, and until these were decided very little grinding could be done. One of the flint components of the objective was exhibited by the Parsons Optical Glass Co. at the Wembley Exhibition, and its quality and homogeneity were almost perfect. As, however, the company wishes in so large a lens to approach so closely as possible to perfection, several alternative flints have been cast, and others are in course of preparation, the best will be selected from them for the Russian telescope. The crown component is a perfect piece of glass, and is undergoing a final and more extensive process of annealing than has hitherto been employed in the manufacture of large telescope objectives. Prof. Kriloff was recently shown in England the report issued by Science Service, and we are authorised to say that "it is a complete misstatement of the matter." He adds: "The lenses for the 41-inch telescope have not yet been ground to curves, but only preliminary calculations of the curves have been made. There can therefore be no question of a test of the complete object-glass having been made and failed. The representatives of the Polkovo Observatory are now testing the discs intended for the object-glass in order to select the most perfect among several which are available."

IT is reported that Miss D. A. E. Garrod of the University of Oxford and member of the Institut de Paléontologie humaine, has discovered fragments of a human skull, including the frontal bone, associated with Mousterian implements at the Devil's Tower, Gibraltar, where she has been carrying on excavations for some time. The fragments were discovered at a depth of about 10 ft. and exhibit characters similar to those of the well-known Gibraltar skull which belongs to the Neanderthal group. If this is correct—and the preservation of the frontal bone, if it is complete, should place it beyond question—it affords a welcome corroboration of the attribution of this skull to the Mousterian period. Miss Garrod had already announced her intention of returning at an early date, and her arrival will be awaited with keen interest by anthropologists. The circumstances of the discovery will no doubt be fully described in the paper which Miss Garrod is to read at the forthcoming meeting of the British Association at Oxford.

MR J. R. JACKSON, Deputy Chief Veterinary Officer of the Ministry of Agriculture and Fisheries, has been appointed Chief Veterinary Officer in succession to the late Sir Stewart Stockman.

PROF A. BRACHET, professor of anatomy in the University of Brussels, has been elected a member, and Prof. Ch. Pérez, professor of zoology in the University of Paris, a foreign associate, of the Royal Academy of Sciences, Letters and Arts (Scientific Class) of Belgium.

THE annual phytopathological meeting of the British Mycological Society will be held at Harpenden, Herts, on July 3. Visits will be paid to the Pathological Laboratory of the Ministry of Agriculture and the Mycological Department of Rothamsted Experimental Station. The secretary, Mr. E. M. Wakefield, Herbarium, Royal Botanic Gardens, Kew, desires intending visitors to inform him not later than June 26.

WE are glad to learn from Mr C. Cuthbertson, F.R.S., that his request for 20 c.c. of krypton and xenon (NATURE, May 15, p 699) met with a ready response. He received several sympathetic replies, while M. Lepape, of the Collège de France, offered a supply of the gases at a very reasonable cost, and they have now reached London by aeroplane.

THE following officers were elected at the anniversary meeting of the Linnean Society held on May 27: *President*, Dr. A. B. Rendle; *Treasurer*, Mr. Horace W. Monckton; *Secretaries*, Dr. W. T. Calman (Zoology) and Mr. John Ramsbottom (Botany). *New Members of Council*: Mr. Reginald Cory, Prof. J. Stanley Gardiner, Prof. E. S Goodrich, Dr. E. Stuart Russell, and Dr. E. J. Salisbury.

THE Institution of Electrical Engineers is celebrating the jubilee of the telephone on June 24, when a luncheon will be held at the Hotel Cecil, Strand, London, W.C 2 In the afternoon Sir Oliver Lodge will deliver a lecture on "The History and Development of the Telephone" in the lecture theatre of the Institution. The lecture will be preceded by the presentation of the Faraday Medal to Col. R. E. B. Crompton. The annual conversazione will be held at the Science Museum, South Kensington, London, S.W.7, during the same evening.

WE have received a letter from Dr. L. A. Kulik of the meteorite department, Mineralogical Museum, Academy of Sciences, Leningrad, U.S S.R., pointing out that the earth passed very close to the path of Pons Winnecke's comet on June 30, 1908, and will do so again on June 27 of this year. He states that on that date in 1908 many meteors were observed and also night luminous clouds, which may have been associated with the approach of the earth to the comet's path. He asks that particulars of observations of any such phenomena this year may be sent to him.

THE spring meeting of the Prehistoric Society of East Anglia will be held at the Royal Anthropological Institute, 52 Upper Bedford Place, on Tuesday, June 22, at 2.30 P.M. Mr. A. Leslie Armstrong will be in the chair, and will give a short account of his recent work of excavation in the caves at Creswell Crags, from which his researches in previous seasons have produced valuable material bearing upon the northward extension of upper palæolithic settlements in England. Among other communications, a discovery of worked flints at Beer, Devon, will be described by Mrs. Mac Alpine Woods, and Mr. H. Rainbow will present some notes on an iron socketed celt from the Thames.

THE ninety-fourth annual meeting of the British Medical Association will be held at Nottingham on July 16-24. The incoming president, Mr. R. G. Hogarth, will deliver his presidential address on July 20, and a popular lecture will be given by Prof Leonard Hill on July 21. The annual exhibition of surgical appliances, foods, drugs, and books will be held on July 19-23. The honorary local general secretary of the annual meeting is Mr. A M. Webber, 2 The Ropewalk, Nottingham. The provisional programme includes the following discussions, the opener's name being given in brackets: The treatment of cancer by lead injections (Dr. W. Blair Bell), relationship of streptococci to scarlet fever and its complications (Dr R A. O'Brien), food deficiency conditions in relation to preventable illness (Dr. S. J. Cowell, Dr. Helen M. M. Mackay, Sir Percy Bassett-Smith, and Dr. J. Wheatley), and the physical and mental effects of fatigue and monotony in modern industrial work.

IN connexion with his article on "Fossil Insects in Relation to Living Forms," published in NATURE of June 12, p. 828, Dr. R. J. Tillyard asks us to state that the very beautiful illustrations were prepared as reductions from the very fine photographic enlargements of the fossils made by Mr W. C. Davies, Curator of the Cawthron Institute, Nelson, New Zealand.

THE Cambridge University Press announces the forthcoming publication, in two volumes, of "Aphasia and Kindred Disorders of Speech," by Dr. H. Head. Vol. 1 will contain a historical sketch of the progress of knowledge in this subject, an account of the new methods of examination employed by the author and the results of his clinical observations. Further sections are devoted to the question of cerebral localisation of function and to novel theoretical conclusions as to the nature and causes of aphasia. Vol. 2 will deal with a series of clinical reports of cases.

THE botanical library of the late Mr. J. S. Gamble, F.R.S., is to be sold by auction on Friday, June 25, at 115 Chancery Lane, W.C.2, by Messrs. Hodgson and Co. The works to be offered for sale include Van Reede's "Hortus Malabaricus," 12 vols.; Wallich's "Plantæ Asiaticæ Rariores," 3 vols.; Royle's "Botany of the Himalayas," 2 vols.; "Annals of the Royal Botanic Garden of Calcutta," 12 vols; and Watt's "Economic Products of India," 6 vols. in 9.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in geography at the University College of the South-West of England, Exeter—The Registrar (June 26). A senior demonstrator and a demonstrator of physiology at St. Bartholomew's Hospital Medical College—The Dean of the College, St. Bartholomew's Hospital, E.C.1 (June 28). Assistant lecturer in engineering, County Technical School, Wednesbury—Director of Education, County Education Offices, Stafford (July 6) A professor of mechanical engineering at the Manchester Municipal College of Technology—The Registrar (July 8). An assistant lecturer in physics in the University of Sheffield—The Registrar (July 8) A head of the mechanical engineering department and a head of the electrical engineering department of Robert Gordon's College, Aberdeen—The Secretary and Registrar (July 12). Lecturers in agriculture, chemistry, and economics at the Imperial College of Tropical Agriculture, Trinidad—The Secretary of the College, 14 Trinity Square, E.C.3 (July 13).

ERRATUM.—In NATURE for June 12, p. 839, last paragraph, for "short" read "Shortt."

Research Items.

ROCK PAINTINGS ON THE WEST COAST OF THE GULF OF CARPENTARIA.—Mr. Norman R. Tindale in vol. 3, part 3, of the *Records of the South Australian Museum*, in the course of the second part of his account of the natives of Groote Eylandt and the west coast of the Gulf of Carpentaria, discusses their pictorial art. They use four pigments—red, yellow, black and white. Three of these—white kaolin, yellow, a limonite and black, manganese oxide and clay—are found locally. The red pigment—a hæmatite—is obtained by trade from the interior of Arnhem Island in the country of the Rembarunga, who pass it on to various other tribes. It is much valued and used in colouring utensils, weapons, ceremonial objects, canoes, apparel, ornaments and persons. The pigments are produced by rubbing on a stone. The starchy liquid obtained by bruising the fleshy stems of various tree orchids is sometimes used instead of water for mixing, because it gives adhesive qualities to the colours. Brushes are either chewed sticks, pieces of bark, or pieces of leather one inch long fastened to a handle of the same length with gum or wax. Two or more colours are sometimes superimposed or mixed to give a special effect or tint, such as salmon colour. The designs are in most cases built up of dots and straight lines with occasional circles and other geometric combinations. No meaning is now known for the geometric designs, but sometimes the well-defined form of an animal is the central object. Tracing designs and pictures on the ground is a common amusement around the camp fire. Tracks of animals and birds are also cleverly imitated. During the enforced leisure of the wet season, designs are painted on the walls of rock-shelters and of the bark huts. The Ingura cave- and hut-paintings usually relate to sailing canoes, dugongs, turtles, fishes, parties of human figures, and hunting scenes. Hands are depicted by coating the rock with red clay on which the hand is imposed and used as a stencil, the outline being shown in white with kaolin.

SONGS OF THE COPPER ESKIMO.—In a further instalment of the Reports of the Canadian Arctic Expedition, 1913–18, forming vol. 14 of the series, Mr. D. Jenness, with the assistance of Miss Helen H. Roberts, deals with the songs collected by the Southern Party which worked on the Arctic mainland and adjacent islands, in this case at Barnard Harbour, in Dolphin and Union Strait, their headquarters. The songs were recorded by phonograph, and with some difficulty, as the Copper Eskimo had not previously been acquainted with the instrument, and thought a spirit was reproducing their words. It is, in fact, their custom not to sing their songs out of doors but only under cover, because they believe that in the former case a spirit might carry away their words and rob them of the breath of life. The songs recorded were, for the most part, dance songs and some incantations. The latter, though fewer than the dance songs, are sufficiently numerous to indicate that they form an important element in Eskimo life. All given here are incantations for fine weather, except one which is for healing the sick. The dance songs are essentially topical. They fall into two classes, the *pisiks*, in which the principal performer beats the drum, and the *atons*, in which one of the chorus of dancers beats the drum and the principal dancer's hands are free. A study of the distribution and comparison of the dances themselves suggests that the two dance forms were originally quite separate, and that the *pisik* is the characteristic form among the eastern branch of the race, predominating among the Copper Eskimo, and being known in the Mackenzie delta, while the *aton* belongs peculiarly to the western division, is the prevailing form in the Mackenzie delta, and exists in a minor form among the Copper Eskimo.

CRUSTACEA OF THE THAMES ESTUARY.—A report on the sea fisheries and fisheries industries of the Thames Estuary, prepared by the late Dr. James Murie, was published in 1903 by the Kent and Essex Sea Fisheries Committee. Mr W. Pollitt, Librarian and Curator of the Public Libraries and Museum, County Borough of Southend-on-Sea, writes: "Of Part II of this work only the first section (36 pages) was set up in type, and it is not probable that the work will be completed." He has for disposal practically the whole of the copies of this section of Part II and will be glad to forward one or more to any person interested. There should be many people wishing to avail themselves of this offer as the section in question is a continuation of Dr. Murie's notes on the Crustacea of the Thames Estuary, containing valuable local information gathered from various sources as well as much original observation. These pages deal entirely with prawns and lobsters. The author adds to his excellent account of the common prawn *Leander serratus* in Part I descriptions and details of distribution with notes on breeding of three others—the white prawn *L. squilla*, Leach's prawn *L. adspersus*, and the ditch prawn *Palaemonetes varians*, directing attention to the fact that the prawn family is more widely distributed in the Kent and Essex area than has been generally supposed. In 1923 Gurney (*Proc. Zool. Soc.*, London) gave a good general survey of all these together with *L. longirostris*, in which he states that *L. adspersus* (= *Palaemon Leachii*) is "by no means an abundant species," although "it is taken in some numbers by the eel catchers." Both this species and *L. squilla*, the so-called "small prawns," are, according to Dr. Murie, frequently captured in the Thames Estuary together with the larger species, and although no separate fishery is established for these they are certainly of some commercial value. It would be a great pity if this unfinished paper were lost owing to lack of knowledge of its existence.

THE OYSTER-SHELL SCALE INSECT.—Although the oyster-shell scale, *Lepidosaphes ulmi*, has been known as a pest in the United States since 1794, only recently has any investigation been made of the differences between those found on apple and those on other host plants, *e.g.* lilac. Grace H. Griswold (Memoir 92, Cornell Univ. Agr. Exp. Stat., 1925) has made a comparative study of the two forms. The author points out the differences in morphological characters: second stage larvæ from the apple have fewer dorsal glands than larvæ from lilac; the pygidia of adult females from the apple have fewer circumgenital pores, insects from the apple are slightly smaller, and observations on the development during five years show that the apple insects are in advance of those on lilac at every stage. At Ithaca, where the work was done, both forms have only one generation. The lilac form is found also on shade trees. Transfer-experiments have shown that insects from apple can complete their development on lilac and on other host plants, but in no case did insects of the lilac form live any length of time on apple or on pear. Whether the differences between the two forms are sufficient to warrant the erection of a new species or only of a new variety for the form on lilac is left in abeyance. Observations are added on the most common chalcid parasite, *Aphelinus mytilaspis*, which attacks the oyster-shell scale.

ORGANISATION IN PROTOZOA.—In an article on organisation and variation in Protozoa (*Sci. Monthly*, April 1926), Prof. G. N. Calkins points out that organisation in Protozoa is as definite and fixed as in any type of living things; that it is represented by visible structures which are not only temporary but are also subject to changes with metabolic activities. These visible structures are formed anew at conjugation or at fertilisation generally, or when parthenogenesis occurs, and they are formed anew at periods of cell division. With fertilisation, with endomixis, and with cell division there is evidence that the cell is completely reorganised and that the fundamental invisible organisation starts 'with a clean slate' after every one of these deep-seated phenomena. Gametes, when formed, are so modified that without fertilisation they cannot live, and ciliates without conjugation or endomixis in the majority of cases will live only with weakening vitality which ends in death.

INHERITANCE OF EGG-COLOUR IN BIRDS.—Certain writers have held that xenia exists in birds, *i.e.* that when species or strains differing in egg-colour are mated, the eggs laid will show changes in colour in the direction of that of the breed to which the male belongs. This has been recorded in crosses between canaries and finches, and also among domestic fowls. In an investigation which included a careful study of the variability of egg-colour in Leghorns (eggs nearly white) and Orpingtons (eggs brown), Kopec (*Journal of Genetics*, vol. 16, No. 3) concludes that no such effect exists. He finds a seasonal variation in egg-colour, the shell being darker during the winter months and lighter in summer. The colour also depends upon the age of the hen and whether she has previously been laying. Curves of egg-colour from the reciprocal matings, compared with control hens without mating, correspond closely in their seasonal variation. Repeated injections of Orpington testicular tissue into Leghorn hens and vice versa also produced no effect. It is concluded that seasonal variation in colour will probably account for the previous supposed observations of xenia.

LAVENDER OIL FROM THE IRISH FREE STATE.—Prof. J. Reilly, Mr. P. J. Drumm and Prof. C. Boyle of University College, Cork, have collaborated in a preliminary chemical examination of lavender oil distilled from plants of lavender grown at Cork and compared with oil obtained from English, French and Spanish sources. These workers have definitely in view the establishment of the cultivation of lavender and distillation of the oil as an Irish industry, and regard their preliminary laboratory experiments as hopeful in result and worthy of extension. Their paper is published in the *Economic Proceedings of the Royal Dublin Society*, vol. 2, No. 16, April 1926.

STARCH AND TRANSLOCATION.—We are beginning to realise how little is known about this problem. Starch is formed in the green assimilating tissue and in reserve organs of plants, but starch grains are also found in the parenchyma associated with the vascular strands. This latter starch is often spoken of as 'transitory starch' (the *wanderstarke* of the Germans), and the view has been taken that its formation by temporarily removing sugar from the cell sap, steepens the concentration gradient of the sugar along the vascular channel, which is assumed to be the driving force in the diffusion of the sugar. E. G. Pringsheim, basing himself in part upon the recent paper of his pupil, K. Bernhauer (*Beih. z. botan. Zentralbl.* 41, p. 84, 1924), reveals the inconsistencies of this point of view and its lack of experimental support in a brief discussion of the subject in *Die Naturwissenschaften* for April 9. Tollenaar has recently calculated that as starch appears in the chloroplasts of the tobacco leaf after five minutes' exposure to light, starch formation must follow when the concentration of sugar in the sap is increased by at most 0·01 per cent. On the other hand, as starch formation does not occur in a darkened strip of this leaf when the rest of the leaf is continuously illuminated for three days, apparently migration of sugar from the illuminated region is unable to raise the concentration in the darkened region by 0·01 per cent. in this time. Either, then, sugar is not actively translocated, or starch-formation is not simply determined by the sugar concentration; in any case the phenomena of starch formation and hydrolysis in the plant require much closer experimental analysis. Pringsheim seems to incline to the view that starch formation in starch leaves is of advantage as preventing an increase of turgor, which in sugar-storing leaves may reduce photosynthetic efficiency.

THE REVILLAGIGEDO ISLANDS.—Last summer the California Academy of Sciences, with the help of the U.S. Navy Department, sent an expedition under Dr. G. D. Hanna to the little known Revillagigedo and Tres Marias Islands off the Pacific coast of Mexico. Dr. Hanna gives a general report on the work of the expedition in the *Proceedings of the California Academy of Sciences*, 15, pp 1-113. The Revillagigedo Islands have never been uninhabited, although their possibilities as a sheep farm have been considered more than once. There has thus been no interference with the natural fauna and flora. The Tres Marias Islands, which lie relatively near the mainland, are inhabited. The narrative of the expedition refers to many interesting collections but contains no summary of the result of the expedition as a whole. This is promised in a series of further reports.

SALINITY OF NILE WATER.—Some investigations by Mr. R. Aladjem on the seasonal variation of salinity of Nile water at Giza are published in Bulletin No. 69 (Technical and Scientific Service, Cairo). Mr. Aladjem shows that the alkaline portion of the dissolved matter in the Nile is small and is seldom greater than 18 parts per million. Moreover, he shows that the low Nile contains more sodium and potassium and the high Nile more calcium and magnesium. This appears to indicate that water laden with alkaline bicarbonates drains into the river from the subsoil during low water, or that some calcium and magnesium of the bicarbonates are thrown down at that stage of the river. The irrigation water used in Egypt thus contains more calcium and magnesium than sodium and potassium, which prevents the soil becoming alkaline, compact, impermeable and comparatively barren. Detailed tables give the analyses of the Nile water at Giza throughout 1924 and 1925.

CRETACEOUS AMMONOIDS OF EASTERN AUSTRALIA AND JAPAN.—The Ammonoids of the Rolling Downs formation of eastern Australia have been studied by Dr. F. W. Whitehouse (*Memoirs of the Queensland Museum*, 8, 3, 1926, p. 195, pls. 34-41). They are especially characterised by the profusion of heteromorphic forms, hitherto referred to Crioceras, for which several new genera are instituted. The author has been able to recognise zonal horizons in the Rolling Downs formation belonging to the Hauterivian, the Aptian and the Upper Albian. Ammonites from the Chalk of Japan are described by H. Yabe and S. Shimizu (*Science Rep. Tôhoku Imp. Univ.*, Sendai, ser. 2, Geol. 8, 4, 1925, p. 125, pls. 30-33); they belong to the family Prionotropidæ, which is rather rare in Japan.

Permian Insects.—In part 7 of his work on the Permian insects of Kansas (*American Journ. Sci.*, 11, 1926, p. 133), Dr. R. J. Tillyard deals with the Mecoptera or scorpion-flies, an order with comparatively few representatives at the present day but not uncommon as a fossil, especially in the Upper Permian and the Mesozoic. From the Lower Permian of Kansas the author describes sixteen species belonging to six new genera. From what is known of the climatic conditions of Kansas in Permian times, Dr. Tillyard infers that the interpolation of the pupal stage in the life-history of the scorpion-flies was not for protection against severe cold, but that drought and heat were the determining factors. Since the Mecoptera are well represented in the Lower Permian, there can be little doubt that earlier forms existed, and the author believes that the Upper Carboniferous genus Metropator, hitherto placed in the Protorthoptera, is a true Mecopteron and a direct ancestor of some of the Lower Permian forms.

Fibrous Crystals of Sodium Chloride.—In further reference to notes which have appeared in Nature (October 24, 1925, p. 610, and March 13, 1926, p. 395) we have received a communication from Mr W. A. Macfadyen, Longships, Capel-le-Ferne, near Folkestone, enclosing some very beautiful specimens of fibrous and banded crystals of naturally occurring rock salt. One set of these crystals, about 2 cm. in length, is stated to be common in Egypt as secondary infillings in small fissures close to the weathered surface of the ground, especially in the soft sandy limestones and green shales of Miocene age. These specimens were found at Shallufa, ten miles north of Suez. The other crystals, which form fibrous bundles 10 cm. in length closely resembling sal ammoniac, were found near Gebel Gharamul in the eastern desert of Egypt, and are said to form the domestic salt supply of the Ma'azah Bedouin. The crystals are extremely beautiful, and are evidently parallel growths, but the facets are not sufficiently sharp to give a clear indication of the direction of the axes.

Dielectric Constants.—The issue of the *Physikalische Zeitschrift* for April 15 contains a summary of more than forty pages, by Dr. O. Bluh of Prague, of the practical and theoretical work done on dielectric constants during the past fourteen or fifteen years. So far as the theory is concerned, progress has been mainly in the application by Debye and others of the idea that each molecule is a dipole with a positive and a negative electric charge, first put forward by Sutherland in 1895 to explain the effect of temperature on the dielectric constant and the existence of anomalous dispersion. On the practical side, older methods of measurement of the constant have been improved, and new methods, generally depending on the use of the triode valve, have been devised. Gases and vapours have been investigated to a higher degree of accuracy, and the effects of temperature and pressure on the constants of liquids determined between 87° and 433° absolute and up to 200 atmospheres. Solutions of liquids in each other and of solids in liquids give results so divergent that no general laws have been evolved, but there seems little doubt that the dielectric constants of solutions play an important part in biological processes. In the case of solids the advances have been less extensive.

The Preparation of Levulose.—No. 519 of the *Scientific Papers of the Bureau of Standards*, by R. F. Jackson, Clara G. Silsbee and M. J. Proffit, describes the preparation of levulose, the sweetest of the sugars, from the Jerusalem artichoke and the dahlia, which contain considerable amounts (8·5 to 23·8 per cent. and 9·3 to 14 per cent. respectively, in the samples examined). After extraction the plant juices, consisting largely of polysaccharides, are converted to sugar by acidifying, and methods of purification are given in the paper. Crystallisation, a process previously requiring the use of absolute alcohol or glacial acetic acid, may be carried out by carefully controlled cooling and seeding of the aqueous syrup.

Electrometric Titration of Halides.—The estimation of halides by electrometric titration is described by W. Clark in the *Journal of the Chemical Society* for April 1926. A calomel cell is joined by means of an ammonium nitrate bridge to a tube dipping into the solution under investigation and silver nitrate is added drop by drop, while the electromotive force is read by means of a potentiometer. The end point is indicated by the maximum rate of change of E.M.F. With mixed halides, the breaks in the E.M.F. curves indicating the respective end points are displaced by solid solution effects. The addition of ions strongly adsorbed by silver halides, such as barium and sodium nitrates in 5 per cent. solution, gives correct end points for a wide variation in proportions of the constituents of the mixtures. The results of the work are applied to the examination of the materials used in the manufacture of photographic emulsions.

Radio Wave Propagation.—Radiotelegraphists have known for some years that when very short wave-lengths are used for transmission, the intensity of the received signals decreases as the distance from the transmitter is increased until it is too small to be observed, the distance then being of the order of one hundred miles. As the distance is further increased the signals are too faint to be detected over a well-defined interval. At a greater distance the signal strength rises to a maximum value and finally gets weaker gradually. The distance of the transmitter from the further edge of the interval of silence is generally called the 'skip' distance. This distance increases rapidly as the wave-length is diminished. For a specified wave-length it is longer at night than in the day, and it is longer in winter than in summer. Dr. Hulburt, in the *Journal of the Franklin Institute* for May, gives an interesting theory of radio wave-propagation round the earth which has the merit of giving simple explanations of most of the observed phenomena. He makes the assumption that there is a Kennelly-Heaviside layer in the upper atmosphere which is rich in electrons. From experiments carried out in the research department of the American Navy, it appears that for wave-lengths of 16, 21, 32 and 40 metres, the skip distances during daylight are 1300, 700, 400 and 175 miles respectively. The night skip distances are more than twice as great. The author considers that this phenomenon proves that the transmitted wave consists of two parts, one of which clings to the surface of the earth and decreases rapidly in intensity, while the other moves in an upward direction and returns after refraction at the conducting layer to the earth. Making certain assumptions as to the connexion between the electron density and the height above the earth, he concludes that during the daytime the electron density is a maximum at a height of between 70 and 150 miles. At night-time, when the sun's rays are absent, recombination of ions and electrons will occur. The electron density, therefore, becomes less and the radio rays must search higher altitudes before being turned back to the earth.

Activities of the South African Museum.

In the first report that he presents as director of the South African Museum, Cape Town, Dr. Leonard Gill insists on the need for more space. In spite of this the staff goes on collecting An expedition was made to the Kaokoveld in South-West Africa, carrying previous work as far as Zesfontein, where lives the decaying remnant of the Topnaar Hottentots; a further expedition was starting for the country north of Zesfontein, of which the natural history is almost unknown. Other expeditions were to Gordonia, between Upington and the border of South-West Africa, and to the Langebergen behind Swellendam, in continuation of the exploration of the mountain ranges in the south-west of the Cape Province. Various traces of early human occupation were also investigated. The whole report bears witness to activity in many directions in spite of crowding and the small number of the staff.

The output of the museum during the past year is represented by the issue of six parts of the *Annals of the South African Museum*. The old-established plan by which the papers are classified more or less strictly into homogeneous volumes (botanical, geological, entomological, etc.) is awkward in that it keeps so many volumes open for rather long periods, but it is decidedly convenient when once the volumes are finished and bound. The large amount of the year's work refers to South-West Africa (the former German territory), which is explained by the fact that a number of expeditions from the Museum have been at work in that territory in recent years. They have gone there by special invitation of the local Administration and with the aid of grants from it—an unusual example of enlightenment which deserves recognition. We are informed that several further papers on the flora and fauna of South-West Africa are already in type. Considering the fewness of their numbers, the amount of scientific work turned out by the members of the Museum staff themselves is noteworthy. It is in part due to the fact that the Museum itself is still awaiting its urgently needed extensions. Thus 'gallery work' is largely paralysed—a bad thing for the public, though it allows the staff more time than they would otherwise have for research.

Thanks mainly to the persistence and energy of Dr. J. D. F. Gilchrist, our knowledge of the marine fishes of South Africa, which was very inadequate some thirty years ago, is now approaching completion in regard to the characters of the species and their distribution. At the beginning of the century a survey of the shallower waters, up to 50 fathoms, of the Cape seas, succeeded in bringing to light many new forms, and also in discovering new fishing grounds. During the last five years a further survey has been carried out on a larger scale, its operations extending to Natal and including the deeper waters. Large collections from Natal made by Dr. Warren in 1906, and more recently by Messrs. Romer Robinson and H. W. Bell Marley, have been sent to the British Museum (Natural History) and have been described.

The present is an appropriate time for the results obtained to be brought together, and Mr. K. H. Barnard's memoir (*Annals of the South African Museum*, vol. 21, Pt. 1, "A Monograph on the Marine Fishes of South Africa, Part 1") should be of considerable service to ichthyologists and others interested in the fish fauna of South Africa. The scope of the work is much wider than the title would suggest, as it includes not only the fishes of the coasts of the Union of South Africa, but also those of East and West Africa northwards to 15° S., and oceanic fishes that have been recorded from within 200 to 300 miles of the east and west coasts and 400 miles southwards.

The fishes of Natal are mostly tropical, whereas those of the Cape are temperate and show Mediterranean affinities; we think that when Mr. Barnard comes to the perches, gobies, blennies, etc., which are so numerous in the Indo-Pacific region, he may regret that he has taken in the east coast northwards to Mozambique, and that only the fact that this area has not been too well explored will save his memoir from being overburdened with tropical species.

A number of papers enumerating and describing species belonging to various groups of S. African insects have been issued during the year. In a country so extensive as South Africa, animal life is abundant and of great interest, and we look forward to the time when the Government of that country will see its way to publish an authoritative "Fauna of South Africa." A model for such a work will be found in the "Fauna of India" series issued by the Secretary of State for India.

In vol. 19, Pt. 4, of the *Annals of the South African Museum*, 1925, Mr. L. B. Prout describes certain new species of Geometrid moths from material that has accumulated since his previous paper on the subject (*Annals S.A. Museum*, 1917), two well-executed coloured plates accompanying this article. In the same part Mr. F. W. Edwards deals with a number of species of Mycetophilidæ and Bibionidæ contained in the Museum collections. The most interesting feature brought to notice is the discovery of a living species of Heterotricha, a genus which has only been previously known in a fossil condition contained in Baltic amber.

Part 1 of vol. 23 of the *Annals* of the Museum is devoted to an extensive illustrated memoir on the Hemiptera of South-West Africa by Dr. A. J. Hesse. It lists all the known species of Heteroptera and Homoptera from that region, excepting those belonging to the families Jassidæ, Aphididæ, and Coccidæ. The Hemiptera of South-West Africa have been little studied in the past, and it is perhaps not surprising that as a result of the Museum expeditions up to 1924, together with the efforts of other collectors, 11 new genera and 58 new species are established. The most extensive additions pertain to the families Reduviidæ (3 new genera, 11 new species) and Fulgoridæ (5 new genera, 17 new species).

"Palæontological Papers published in conjunction with the Geological Survey" were added to the natural history publications of the South African Museum about a quarter of a century ago, thus extending their scope and usefulness. In the matter of the Mollusca, the non-marine early received attention, and if the papers have been few in number they have been important in matter. So early as 1900, Mr. W. E. Collinge had two papers on the slugs of South Africa; while one whole big part was devoted in 1912 to Major Connolly's valuable "Reference List of South African Non-marine Mollusca." This last was a piece of systematic work which has great value, on account of its carefully compiled synonymy and nomenclature, to others besides the immediate circle of those for whose benefit it was drawn up.

Lately another important molluscan paper, this time anatomical in character, has appeared (vol. 20, Pt. 4) from the pen of that past master in molluscan anatomy, Mr. Hugh Watson. He deals with "The South African species of the Molluscan genus Onchidella," and in addition to their anatomy discusses their affinities with the species found in other parts of the world and the geographical distribution of the genus. Eight excellent plates from the author's pencil and camera, with their keys and a map, are appended in illustration.

A first contribution to "Reports on the Marine Mollusca in the Collections of the South African Museum," by J. R. le B. Tomlin on the family Turritellidæ, accompanies the preceding. What it wants in length this paper makes up in importance. It is a purely systematic paper, but describes and illustrates two new species of Turritella, besides introducing a new term, "scalarescence," to denote a tendency to looser coiling sometimes exhibited in these shells. Conchologists will assuredly look forward to meeting with further such contributions in these *Annals*.

Vol. 22, Pt. 1, of the *Annals* contains five papers on South African fossils and fossil woods. Africa, especially in its more central parts, is still in large measure the undiscovered land so far as its extinct animals are concerned. The veil has been lifted a little on its Mediterranean borders chiefly through the work of the late Dr. C. W. Andrews. On the east coast, where the remains of the largest forms of extinct reptiles have been discovered, there is possibility of great further discovery. In the south our knowledge is fuller and of longer standing, though even here it must be recognised that the known and described forms can be only the merest fraction of the animals that lived and evolved there, and exploration is far from being finished. In South Africa is the well-known Karroo series of formations, which are perhaps the most important centre of reptilian and amphibian evolution that has as yet been explored. The earlier classical works of Owen, Huxley and Seeley are, many of them, based on specimens from here. So are the more recent classics of Watson and Broom.

In reviewing the labours of various researchers in this field, the assistance rendered by the Trustees of the South African Museum and by the Geological Survey of South Africa must not be underestimated; the *Annals of the South African Museum* contains many important papers on vertebrate palæontology by Broom and S. H. Haughton. A recent number contains the thirteenth paper by the latter author on extinct reptiles and amphibia of the district. The format of the publication, the typography, and the production of the plates are all excellent.

The grasses of Namaqualand, Damaraland, and Ovamboland are listed by Miss S. Garabedian (*Annals*, vol 16, Pt. 2); representatives of most of them are now in the Herbarium of the South African Museum. It is hoped later to issue a list of the grasses of the mountainous country on the west called the Kaokoveld and the sand-dune belt between the mouths of the Orange and Cunene rivers, known as the Namib. Genera are arranged according to the key given by Dr. Stapf in the "Flora of Tropical Africa." Under the different species there are often notes as to the value of the grass as fodder, or its disadvantage as a weed in cultivation or as injurious to grazing stock.

Experimental Investigation of Dengue.

When the Medical Research Board was organised for the Philippines in 1922 at the recommendation of the Surgeon-General of the United States Army, the investigation of the etiology of dengue was one of the most important problems to be studied. Lieut.-Col. J. F. Siler, Majors M. W. Hall and A. P. Hitchins were appointed, and commenced their labours in 1924 at Manilla, and in the *Philippine Journal of Science* of Jan.-Feb. (vol. 29, Nos. 1-2, pp. 304 + 8 plates) they describe their results.

The investigation was most carefully planned and most thoroughly carried out on the model of so many other etiological problems conducted by our American confrères. A very complete history of the disease is first given; the earliest accurate descriptions of dengue in epidemic form are from Cairo in 1779, from Batavia and Java in 1779, and from Philadelphia in 1780, showing that then it was widely distributed, and it still remains so, but there is reason to believe that its original home was in tropical America. Compared with yellow fever, to which the disease has many etiological similarities, this world-wide diffusion is remarkable. Throughout these areas some of the epidemics are often classed as "dengue-like" rather than true dengue, but the authors, after most careful consideration, state that "it would appear that among themselves they differ little, if any more, than do different outbreaks of dengue, and until specific etiological evidence is available the possibility of their essential identity must be borne in mind."

The experiments detailed in this monograph were carried out in the Philippines, and were made on sixty-four American soldier volunteers to determine the transmission of dengue by means of mosquitoes: the men were in screened wards and the mosquitoes used were bred from the egg. In one hundred and eleven biting experiments made by infected females of *Aëdes aegypti* (better known as *Stegomyia fasciata*), dengue was transmitted forty-seven times.[1] All experiments with *Culex fatigans* were negative, thus not confirming the early and useful work by Graham. The filterable virus of the disease is present in the blood of the case only during the first three days of the fever, and requires at least eleven days to develop in the mosquito before it can be transmitted. The infectivity of the insect continues throughout its life but is not passed on to its progeny. It was found that 58 per cent. of those who had suffered from the disease were immune, and in the others the course was modified. The rapidity of the spread of dengue is second only to influenza, but the diseases are not mutually protective.

The results brought out by the inquiry are in striking similarity with those observed in yellow fever, and strongly suggest some group relationship. Though so far in dengue the actual cause has not been definitely demonstrated, yet spirochætal forms have been reported for both. The authors were unable to transmit the infection to animals. From a practical point of view, the authors conclude that as dengue and yellow fever are transmitted by the same mosquito and the mechanism of transmission for each is almost identical, therefore epidemics of dengue and yellow fever are subject to the same control measures; the foremost of which is the reduction of the incriminating mosquito in the affected area; secondly, the protection of patients from mosquito bites during the first three days, by adequate mosquito nets, etc., during both day and night.

The previous work of other investigators is duly recognised and acknowledged, but the research here recorded is the most thorough and admirable on the subject.

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[1] Of the sixty-four volunteers used, dengue was produced experimentally in fifty-two, or 81 per cent.

The Storage of Eggs.

MORE than four thousand million eggs are consumed in Great Britain during the course of a year; but this number would probably be increased if satisfactory methods of storing eggs produced at the glut period in the spring with the view of their consumption later in the year were generally introduced, especially as the producers would be encouraged to increase their stock, since the demand and the price fetched would show less marked fluctuations. But for a stored egg to be the equivalent of a new-laid egg in all respects requires considerable attention to detail: the factors on which good results depend are discussed by T. Moran and J. Piqué in a recent publication of the Department of Scientific and Industrial Research.[1]

In the first place, only carefully selected eggs should be submitted to storage: they must be clean and should never have been exposed to a temperature greater than 60° F, otherwise a certain amount of development of an egg, if fertile, may have occurred, resulting in its decomposition later in the store. The quality of an egg can be judged by its transparency to light, this process of examination being termed 'candling' A new-laid egg appears clear and transparent, the yolk being vaguely seen as a rosy-tinted mass: the air chamber is small. As the egg ages it becomes less transparent, appearing slightly marbled; the yolk is movable along the long axis and the air chamber is larger. Bad eggs appear opaque on candling.

In the second place, attention must be paid to the method of packing when, as is most usual, the eggs are kept in the cold store; the material used should be clean, odourless and moisture-proof, and the eggs should be so packed that a free circulation of air can occur around them. The temperature of the store should be maintained at 32-33° F. and be kept as constant as possible: the humidity of the air should be about 80 per cent.: a higher humidity favours the growth of moulds, whilst a lower humidity increases the rate of evaporation of moisture from the eggs. Under the conditions specified the loss of weight of the stored eggs is about 2·68 per cent. over a period of seven months. A free air circulation is essential to keep them in good condition and prevent the growth of moulds. The authors consider in detail the various methods of packing eggs and of obtaining the requisite temperature and humidity in the storage chamber: they suggest that the loss of weight by evaporation may possibly be prevented by wrapping the eggs in waxed papers, although this would presumably increase their cost somewhat.

Certain changes occur in the eggs during cold storage: the white becomes more viscous, losing water both to the yolk and externally by evaporation, the yolk membrane becomes more delicate, and when the egg is broken the yolk also is very liable to break, a familiar sign of age in an egg Moreover, after about six months the eggs acquire an unpleasant taste from the packing material unless, as mentioned above, this is odourless and moisture-proof. The food value of stored eggs, however, is probably little inferior to that of new-laid: no loss of vitamin A has been detected even after long storage.

The removal of eggs from cold store requires care, since unless their temperature has risen to that of the outside air, moisture will be deposited on their surfaces, or they will 'sweat,' as it is called: and a damp egg does not fetch so good a price as a dry one. The process of 'defrosting' requires about twenty-four hours.

After a short account of the storage of eggs in water-glass or lime-water, T. Moran describes some experiments on the effects of low temperatures upon eggs. After freezing and thawing again, it is found that the liquid part of the white has increased and the viscous part decreased in amount, the extent of the change depending on the temperature reached and the time of exposure to that temperature. On the other hand, the yolk shows no change unless the temperature has fallen below −6° C., and unless freezing has actually occurred. If the egg is kept at this temperature for a sufficient length of time, on thawing the yolk is found to be in a stiff pasty condition; if the processes of freezing and thawing are carried out sufficiently rapidly this change does not occur. It appears to be due to a precipitation of lecitho-vitellin, so that re-solution does not occur on thawing: it is to be noted that simple freezing alone, at a temperature above −6° C., does not produce the change, so that it occurs at a time when the egg is frozen solid

The effect of temperature on the life of the embryo was also studied. At −6° C. the embryo dies immediately: fertility is maintained longest at 8-10° C., up to a maximum of about five weeks. The author points out in this connexion that the embryo is cold blooded up to about the twentieth day of development.

Apart from its scientific interest, the report merits the attention of all those engaged in the commercial production of eggs in Great Britain.

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[1] Department of Scientific and Industrial Research: Food Investigation. Special Report No. 26: The Storage of Eggs. By T Moran and J. Piqué. Pp. viii+80+9 plates. (London: H M. Stationery Office, 1926.) 1s. 3d. net.

Commonwealth Fund Fellowships.

THE Committee of Award for the Commonwealth Fund Fellowships has made the following appointments to the twenty fellowships tenable by British graduates in American universities for the two years beginning in September 1926:

Mr. A. M. Adamson, University of St. Andrews, to the University of California, in zoology; Mr. F. N. Astbury, University of Liverpool, to Columbia University, in architecture; Mr. I. W M. A. Black, University of St. Andrews, to Yale University, in physical chemistry; Mr. F. P. Chambers, Clare College, University of Cambridge, to Harvard University, in architecture; Miss M. E. Cranswick, King's College, University of London, to Columbia University, in education; Mr. R. Fisher, Hertford College, University of Oxford, to Yale University, in economics; Miss I Gordon, University of Aberdeen and the Imperial College of Science and Technology, London, to Stanford University, in zoology; Miss H. A C. Green, Westfield College, University of London, to the University of Pennsylvania, in literature; Mr. D. B. Harden, Trinity College, University of Cambridge, and the University of Aberdeen, to the University of Michigan, in archæology; Mr. R. L. Lechmere-Oertel, University of Birmingham, to Columbia University, in engineering; Mr. K. A. H. Murray, University of Edinburgh, to Cornell University, in economics; Mr. E. P. Mumford, University of Manchester and Christ's College, University of Cambridge, to the University of California, in agriculture; Mr. M. A. Peacock, University of Glasgow, to Harvard University, in geology; Mr. G. S. Pryde, University of St. Andrews, to Yale University, in history; Mr. C. B. Purves, University of St. Andrews, to Johns Hopkins University and the Bureau of Standards, Washington, D.C., in organic chemistry; Mr. R. A. Robb, University of Glasgow, to the University of Chicago, in mathematics; Mr. W. Rule, Armstrong College, University of Durham, to Cornell University, in physics; Mr. F. J. Whelan, University College, Cork, to Harvard University, in literature; Mr. H. Williams, University of Liverpool and the Imperial College of Science and Technology, London, to the University of California, in geology; Mr. N. C. Wright, of Christ Church, University of Oxford, School of Agriculture, University of Cambridge, and the University of Reading, to Cornell University, in agriculture.

The purpose of the Commonwealth Fund is to promote mutual amity and understanding between Great Britain and the United States by offering opportunities for education and travel in the United States to young British graduates of character and ability. By terms of the Foundation it is necessary to effect a geographical distribution of Commonwealth Fund Fellowships among the universities of the United States from the Atlantic to the Pacific, without handicapping any individual in the advanced work on which he will be engaged. There were 178 applicants this year for fellowships, offering in all twenty-nine different subjects.

University and Educational Intelligence.

ABERDEEN.—The University Court has appointed Dr. Allan W. Downie to the Georgina M'Robert lectureship in pathology, with special reference to malignant diseases.

CAMBRIDGE.—The University has been officially informed that the Statutes recently made by the University of Cambridge Commissioners have been approved by the King in Council, no petition or address having been presented against them, while they were laid before both Houses of Parliament.

The members of the University Automobile Club, which has now been wound up, have offered to the University the sum of 450*l*. to endow an annual Ricardo Prize in thermodynamics.

The report of the Committee for Geodesy and Geodynamics contains some interesting references to Dr. Vening Meinesz's method of determining the value of g; based on g at Potsdam 981·274 cm./sec.^{2}, he obtained a value for Cambridge 981·265; independent observations made by Sir G. Lenox-Conyngham and Mr. Manley with the Science Museum pendulums gave the value 981·266. These pendulums are being taken by Mr. Manley this summer to Eastern Greenland in order that he may make a gravity determination near "Pendulum Islands," where General Sabine made observations in 1823 in latitude 74° 32′ 19″ N. During the absence of Sir Gerald Lenox-Conyngham in Japan at the Pan-Pacific Science Congress, Lieut.-Col. J. E. E. Craster will act as his deputy.

The report of the Director of the Solar Physics Observatory records the safe return of the instruments taken to the Crimea in 1914 to observe the total eclipse of the sun. A 6¼-inch achromatic object-glass which used to belong to Sir George Stokes has been presented to the Observatory by Mrs. Laurence Humphry.

Dr. A. C. Haddon is retiring from the readership in ethnology, and the General Board of Studies will proceed shortly to appoint a successor. The stipend is 660*l*. per annum, with an allowance of 200*l*. per annum if the reader is not a fellow of a College. The appointment will in the first instance be for three years from October 1. Applications should reach the Vice-Chancellor on or before Wednesday, July 14.

DR. W. EITEL has been nominated professor of mineralogy at the Technische Hochschule in Charlottenburg.

VACATION courses for mechanics and glassblowers, under the auspices of the "Vereeniging tot Bevordering van de Opleiding tot Instrumentmaker" (Society for the Advancement of the Training of Mechanics), Leyden, Holland, are to be held in August in the workshops of the Physical (Cryogenic) Laboratory of the University of Leyden. Particulars may be obtained from Dr. C. A. Crommelin, the Physical Laboratory, Leyden, Holland.

THE University of London Club, which was founded in 1914 for members of that University, and has its Club House in Gower Street (London, W.C.), has recently undergone a complete reconstruction. One feature of the reconstruction has been the widening of the basis of membership, so as to include graduates of other universities besides London, holders of certain diplomas granted by the University of London or its colleges, and persons who hold certain professional qualifications. A pamphlet giving an account of the Club, and of the facilities provided for the promotion of the social life of graduates can be obtained from the honorary secretary, 19 Gower Street, W.C. The chairman and members' committee of the Club will be At Home on June 22 at 8.30 P.M. to meet the Vice-Chancellor of the University of London (Prof. Gardner) and members of the Senate. The president of the Club is the Chancellor, the Earl of Rosebery.

THE sixth and last of the Watson Chair Lectures for 1926 will be delivered on Monday next at the University of Bristol at 5.30 P.M., the subject being "A Vision Postponed; Grover Cleveland's British-American General Arbitration Treaty killed by the Senate." The holder of the chair this year, Dr. Robert McElroy, professor of American history in the University of Oxford, is the authorised biographer of President Cleveland. The chair was founded in 1919, on the return of the Prince of Wales from his American tour, with the object of "knitting more closely together the bonds of comradeship between the two great English-speaking democracies, upon whose goodwill and friendship the peace of the world depends," and is of interest in connexion with the articles on "The Universities and International Peace," and on the recent awards of Commonwealth Fund fellowships, appearing elsewhere in this issue. The Watson chair has been held in succession by the late Viscount Bryce, Ex-President Hadley of Yale University, President Nicholas Murray Butler of Columbia University, Prof A. F. Pollard of University College, London, and Sir Robert Falconer, President of the University of Toronto. Prof. McElroy's general subject is "Some British-American Crises: an Interpretation." He has delivered five lectures at London, Cambridge, Manchester, Leeds and Edinburgh respectively, and in addition an address, broadcasted by the B.B.C. on May 27, on "The International Mind in the Making."

Contemporary Birthdays.

June 19, 1858. Sir Henry J Oram, K.C.B., F.R S
June 20, 1861. Sir Frederick G. Hopkins, F.R.S.
June 21, 1862. Sir Humphry Rolleston, Bart., K C.B
June 21, 1860. Dr William D. Halliburton, F.R S.
June 22, 1864. Sir Daniel Hall, K C B., F.R S.
June 23, 1843. Prof. Paul Heinrich Ritter von Groth, For Mem.R S
June 23, 1860. Sir W. Baldwin Spencer, K C M G., F R S.
June 23, 1859. Lt-Col. A W Alcock, C.I E., F.R.S.
June 24, 1854. Dr. John A. Voelcker.

Sir HENRY ORAM, Engineer Vice-Admiral, received his technical training in Devonport Dockyard and at the Royal Naval College, Greenwich. He was Engineer-in-Chief of the Fleet from 1907 until 1917.

Sir FREDERICK GOWLAND HOPKINS, known widely for his long-continued researches in chemical physiology, especially in relation to the nutrition of the human subject, has been, since 1914, professor of biochemistry in the University of Cambridge. In 1918 the Royal Society awarded him a Royal medal. He was, indeed, among the very earliest to establish that minute quantities of certain bodies, the nutritive value of which had hitherto been unsuspected, exert an enormous influence upon growth and upon normal adult nutrition. He showed that without these accessory factors—vitamins—a diet otherwise full and seemingly complete is incapable of allowing growth, and even of maintaining body weight or life.

Sir HUMPHRY ROLLESTON, who was born at Oxford, was educated at Marlborough and St. John's College, Cambridge Regius professor of physic in the University of Cambridge since 1925, he was lately president of the Royal College of Physicians.

Dr HALLIBURTON, emeritus professor of physiology in King's College, London, a post which he adorned for thirty-three years, is a Londoner He was educated at University College School, London, and University College. President of the Physiological Section at the British Association's Belfast meeting in 1902, he gave an address on the position (as it then stood) of chemical physiology.

Sir DANIEL HALL was educated at Manchester Grammar School and Balliol College. From 1902 until 1912 he was director of the Rothamsted Experimental Station. As chief scientific adviser to the Ministry of Agriculture and Fisheries, Sir Daniel has now an enlarged scope of work.

Prof. PAUL H RITTER VON GROTH was born at Magdeburg and educated at the universities of Freiburg, Dresden, and Berlin. From 1872 until 1883 he occupied the chair of mineralogy in the University of Strasbourg, leaving to become professor of mineralogy in the University of Munich and curator of minerals in the State Museum, Munich Prof. Paul von Groth is a recognised authority in chemical and physical crystallography. For many years he was editor of the *Zeitschrift fur Krystallographie und Mineralogie* In 1908 he was awarded the Geological Society's Wollaston medal.

Sir BALDWIN SPENCER, formerly (1887–1921) professor of biology in the University of Melbourne, was born at Stretford, Lancashire, and he was educated at Owens College and Exeter College, Oxford A frequent correspondent of NATURE, we note a letter of his to this journal, so far back as 1885, on "The Eggs of Monotremes," and another, in 1886, on "The Parietal Eye of *Hatteria*."

Lieut-Col. ALCOCK was educated at Mill Hill and the University of Aberdeen. For fourteen years he was superintendent of the Indian Museum

Societies and Academies.

LONDON.

Royal Society, June 10.—**A. C Downing, R W Gerard and A. V. Hill** : The heat production of stimulated nerve The method adopted is thermo-electric The thermopile contains about 300 couples of constantan-silver, made by electroplating (Hamilton Wilson), and current is recorded (to 2×10^{-11} amp) by two moving-coil galvanometers coupled by a thermal relay (Moll and Burger) The heat appears in two stages: (*a*) during stimulation there is a rise of temperature of about 7×10^{-6}° C. per second of stimulation; (*b*) in the succeeding ten minutes there is gradual further production of heat about eight times as great as in stage (*a*), which for the present we attribute to a recovery process analogous to that occurring in muscle. Total heat corresponds closely to extra carbon dioxide found by Parker for stimulated nerve. There is difficulty, however, in explaining the *resting* values of oxygen and carbon dioxide found by him and others.—**A. S Parkes** (1) Observations on the œstrous cycle of the albino mouse. The average duration of the œstrous cycle (meta-œstrus to œstrus inclusive) of the unmated albino mouse was 5·7 days. The average duration of the cycle in normal females mated with vasectomised bucks was 11 days. This postponement of the next œstrous period is considered to be due to the formation of a decidua by the uterus, on mechanical stimulus by the vaginal plug, a process which has been demonstrated in the albino rat by Long and Evans. Pregnancy follows the detection of the vaginal plug in about 70 per cent. of cases, the gestation period being 19 days in almost all cases. The effect of lactation is entirely to inhibit œstrus (apart from the immediate post-partum period) for at least three weeks if an appreciable number of young are suckled. After the inhibition due to suckling, the cycle goes suddenly back to normal, even in cases where lactation is prolonged. Unilateral ovariotomy does not appear to influence the cycle. (2) On the occurrence of the œstrous cycle after X-ray sterilisation Of 25 mice sterilised by exposure to X-rays at three weeks old, 22 experienced at least one period of œstrus when puberty was reached. In all, 53 periods of œstrus were observed in these animals, many of which exhibited a series of complete cycles of the normal length. Since none of these animals had oocytes, follicles, or follicular tissue in the ovaries, neither follicles nor *corpora lutea* appear to be essential to the occurrence of the normal cyclic activity of the uterus and vagina The œstrous-producing hormone seems to be formed by the inter-follicular tissue, though also possibly by the follicles under normal conditions.—**I. Gordon** : The development of the calcareous test of *Echinocardium cordatum*. Bilateral symmetry is apparent almost from the beginning. The complex plating characteristic of the adult is only acquired at a comparatively late stage There is no trace of teeth or of the lantern ossicles, but the perignathic girdle is represented by a single internal process. The membrane round the mouth is at first circular, but soon becomes pentagonal and then gradually alters to the 'reniform' outline of the adult peristome.—**H. R. Hewer** : Studies in colour changes of fish (ii.-iv.).—**A. V. Hill** : The viscous, elastic properties of smooth muscle Gasser and Hill found that the sudden release during an isometric tetanus of the skeletal muscle of a frog is followed by an instantaneous drop of tension, and then by a gradual re-development along a curve identical with that of the original rise when stimulation began. This observation has been repeated on the smooth muscles of *Holothuria nigra*, in which the speed of contraction is less than 1/100 of that of frog's striated muscle. The return to the tension characteristic of the new length is precisely similar in its time relations to the initial rise of tension. It is concluded that the development of a contraction during stimulation, and its re-development after release, are due to the same process, namely, the formation of an organised molecular pattern, arranged in space, whether of two or three dimensions, in the fibres of the muscles. Such a molecular rearrangement, either on stimulation or during actual shortening, is the basis of the 'viscous-elastic' phenomena found in all contractile tissues.—J. **Walton**: Contributions to the knowledge of Lower Carboniferous plants. The morphology of the genus Rhacopteris is discussed. The evidence is considered to support the view that Rhacopteris is more probably a fern than a pteridosperm. The presence of a rachis in the angle of the fork of the frond of *Sphenopteris Teiliana* is demonstrated in several specimens, and shown to have some characters of a fertile rachis of Telangium, and is interpreted as indicating the fundamentally pinnate structure of the frond. Thus probably the fructification rachis of *Telangium bifidum* was attached to the frond bearing the foliage pinnules in the angle of the main fork of the rachis, and possibly in many Lower Carboniferous fronds with apparently dichotomous rachis the frond is in reality pinnate in structure.—J. H. **Priestley** and E. **Rhodes**: On the macro-chemistry of the endodermis. —D **Keilin**: A comparative study of turacin and hæmatin, and its bearing on cytochrome The absorption spectra of turacin, hæmatin and hæmochromogen vary with the degree of dispersion of these compounds, and the bands shift from 100 to 200 Å U towards the red end of the spectrum as the degree of dispersion decreases. Artificial hæmochromogens composed of hæmatin and one of the nitrogen compounds can be prepared, showing either three or four absorption bands resembling those of cytochrome. The three components of cytochrome seem to be derived from one hæmochromogen compound, present in two distinct degrees of dispersion (b' and c'), and partly modified (a') by active process of oxidation and reduction in which these components are directly involved.—E. **Ponder**: The equations applicable to simple hæmolytic reactions. Time-dilution and percentage hæmolysis curves of experiment in especial are discussed. The action of the simple lysins on the cells is describable by expressions like those for chemical reactions of the first order, but in which is a term relating to extent of cell surface acted upon. Allowing for the fact that the reaction takes place at cell surfaces only, and not continuously throughout the system, the effect of lysins on suspensions of different strengths is explained in a simple way.—J. P. **Hoet** and P **Kerridge**: Observations on the muscles of normal and moulting Crustacea. Glycogen was found in the muscles of normal hard-shelled Crustacea Only small amounts were found in those of soft-shelled specimens of the same species. An early onset of *rigor mortis*, associated with alkaline reaction, was observed in crustacean muscles poor in glycogen. When glycogen was present in the muscles, there was a post-mortem development of acid comparable with that in mammalian muscle.—C. H. **Best** and H. P. **Marks**: Additional note on the effect of insulin on the lactacidogen content of the skeletal muscles.

Physical Society, May 28—G. **Temple**: Static and isotropic gravitational fields. By limiting the investigation to the consideration of dynamical manifolds which are static and isotropic in character, it is practicable to abandon the notation and theory of the absolute differential calculus, and to substitute some classical theorems of Lord Kelvin and M. J. Liouville. This simplified theory serves to explain the construction and solution of Einstein's field equations, and their application to the problems of planetary motion and of the deviation of light in a gravitational field. It also makes explicit the various assumptions involved in Einstein's theory.—C V. **Raman** and K. S. **Krishnan**: The diffraction of light by spherical obstacles. The diffraction of light inside the shadow, thrown by a small source of light, of a sphere and a circular disc of the same diameter, was studied, with special reference to the relative intensities of the central bright spots. With the source at about 2 metres from the obstacles, with a $\frac{1}{4}$-in. polished steel ball, the bright spot could be detected visually up to 3 cm. behind the obstacle, while with a steel disc of the same diameter, with the edges perfectly sharp, smooth and circular, the spot could be traced up to 2 cm. At small distances behind the obstacles, the spot inside the shadow of the sphere is much feebler than the disc-spot, approximating to the latter farther back from the obstacles, but even at 100 cm. remaining appreciably feebler—A. L. **Narayan** and K. R. **Rao**. On the absorption and series spectra of nickel. The absorption spectrum of nickel was investigated by the under-water spark from $\lambda 6000$ to $\lambda 2000$. In the region $\lambda 3800$ to $\lambda 2100$, 180 wave-lengths were obtained in absorption The majority of these lines were classified by Bechert and Sommer. Intensity values of the absorbed lines showed that the intensity rule and the selection rule for inner quantum numbers were accurately fulfilled. The results confirm the recent classifications of Bechert and Sommer in this spectrum. —H. C. **Hepburn**: The influence of electrolytes in electro-endosmosis. Determinations were made with certain aqueous solutions of electrolytes in glass diaphragms, and values are obtained for the interfacial potential of the Helmholtz electrical double layer. The dependence of the conductivity on the electro-endosmotic flow was investigated by measurements of the current flowing through the diaphragm during each determination, and the data used to trace the variations in the thickness and the charge of the electrical double layer by the application of a formula derived by Smoluchowski.

EDINBURGH.

Royal Society, May 24.—Malcolm **Wilson** and Miss E. J. **Cadman**: The life history and cytology of *Reticularia Lycoperdon*—one of the mycetozoa. After spore germination the blepharoplast arises from the nucleus and divides to form the centrosomes before division of the swarm-cell; four chromosomes are present Fusion takes place between motile gametes which are identical with the swarm-cells. Before fusion of the gametic nuclei several swarm-cells coalesce with the zygote and their nuclei are ultimately digested Ingestion of entire swarm-cells takes place later. The nucleus of the zygote divides repeatedly and the plasmodium is formed; eight chromosomes are present Typical meiosis takes place after the emergence of the plasmodium from the wood, and cleavage and spore formation follow The pseudocapillitium and sporangial wall are formed from masses of degenerating protoplasm—Miss C C **Miller**: The slow oxidation of phosphorus trioxide (Part 2) The production of phosphorus tetroxide by direct oxidation of phosphorus trioxide. When phosphorus trioxide oxidises slowly at low temperature in oxygen containing a trace of water vapour, the only product of oxidation is phosphorus tetroxide.—A. C. **Aitken**: On Bernoulli's numerical solution of algebraic equations. The paper generalises Bernoulli's method of finding the greatest root of an equation. The extension gives a means of computing all the roots of the equation, whether real and different, complex or multiple.

Paris.

Academy of Sciences, May 10.—**Maurice Hamy**: A particular case of diffraction of the solar images —**André Blondel**: Remarks on the establishment of the régime in electrical circuits —**A Desgrez**, **H Bierry**, and **L. Lescœur**: The fixing of sulphuretted hydrogen in the blood.—**Charles Nicolle** and **Ugo Lumbroso**: Granular conjunctivitis of the rabbit and the origin of trachoma.—**Mirimanoff** · The game of heads or tails and the formulæ of Laplace —**J Favard**: Linear differential equations with nearly periodic coefficients —**E. Gau**: The transformation of a system of two partial differential equations in involution into a unique equation of the first order — —. **Lainé**: The application of the method of Darboux to the equations $s=f(x, y, z, p, q)$.—**S Zaremba**. A transformation of the problem of Neumann —**Georges Bouligand**: The continuity of zero order in hydrodynamics.—**A. Alayrac** · The theoretical study of bird-like flight.—**Jean Chazy**: The calculation of the advance of the perihelion of Mercury under the action of the other planets. Comparison of the results of Le Verrier, Newcomb, Doolittle, and Hill. —**Henri Malet** · The invariant expressions met with in electrodynamics in systems in movement.—**Félix Ehrenhaft**. The observation and measurement of very small isolated magnets The apparatus described is capable of determining the magnetic moment of isolated magnets down to a radius of 5×10^{-6}, and can fix the intensity of a magnetic field in an area as small as 0·01 sq cm It will prove useful in problems connected with the magnetic properties of small colloidal particles.—**Jean Thibaud**: A new technique in the use of gratings applied to the study of Millikan's ultra-violet. The use of a vacuum spectrograph with the method of tangential incidence permits the use of a grating with 200 lines to the millimetre instead of 500 to 1100 lines per millimetre used by Millikan, and the photographic plate is placed only 98 mm. from the grating. Details of the results obtained with copper are given —**A Portevin** and **P. Chevenard**: The complexity of the phenomena of tempering certain alloys —**Pierre Jolibois**, **Henri Lefebvre**, and **Pierre Montagne**: The influence of the capacity of the discharge circuit on the decomposition of carbon dioxide under reduced pressure by the electric spark. The decomposition of carbon dioxide under reduced pressure by the spark is strongly influenced by the capacity of the discharge circuit. For a given tube a high degree of dissociation is only obtained if the capacity of the condenser giving rise to the spark is large.—Mlle. **Suzanne Veil**: The magnetochemical reactions of the hydroxides in the presence of hydrogen peroxide.— — **Marinesco**. Adsorption on large molecules in solution Einstein's equation giving the relation between the viscosity of a suspension of fine solid particles and that of the intergranular liquid has been applied to the results of viscosity measurements on solutions of rhodamine (molecular weight 478) in water and various alcohols. The results show that the dissolved molecule is surrounded by a monomolecular layer in which the number of molecules of adsorbed solvent is fixed. Methyl alcohol furnished anomalous figures —**J. Laissus**: The cementation of ferrous and copper alloys by tungsten, molybdenum, and tantalum.—Mlle. **M. Pernot**: The potassium iodomercurates which crystallise in acetone solution. —**Clément Duval**: A general method for the preparation of nitrites. Application to the simple nitrites of cobalt and nickel and to that of cobaltihexammine.—**P Freundler** and Mlle. **Y. Ménager**: The estimation of rubidium by means of silicotungstic acid; the application of this reagent to the detection of rubidium in the ashes of *Laminaria flexicaulis* The fractional crystallisation of the chlorplatinates has been proved to be an unsatisfactory method for determining rubidium in the presence of potassium and sodium, and the use of the silicotungstate ($Rb_8W_{12}SiO_{42}$ at 100° C.) is suggested as preferable. Details are given.—**Jean Meunier**: The detection and estimation of strontium by the spectrographic method in the hydrogen flame.—**J. F Durand**: The direct preparation of mixed organo-beryllium compounds Various attempts to prepare organo-beryllium compounds under the conditions usual for the preparation of the magnesium compounds failed. In one experiment, in which some mercuric chloride was added to the reaction mixture, a compound behaving as $CH_3.BeI$ was obtained.—**R. Weil**: The temperature of paramorphic transformation of cristobalite.—**Paul Picard**. Violutoside, a new glucoside containing methyl salicylate, extracted from *Viola cornuta*. This glucoside was present in the proportion of 0·01 gram per kilogram of fresh plant. The new glucoside is formed from one molecule of methyl salicylate and one molecule of a hexopentose, and is not identical with monotropitoside.—**R. Combes**: The migration of nitrogenous substances in the beech in the course of the autumnal yellowing. —**G. Lafon**: The amplification and collective audition of the beats of the heart and the other sounds of auscultation An account of the application of the methods of radio telephony to replace the stethoscope.—**Jean Saidman** and **L. G. Dufestel**: The visibility of the initial portion of the ultra-violet spectrum. It is shown that the line 365 Å.U. can be perceived by the human eye under favourable conditions. That it is not usually seen under ordinary conditions is due to the fact that the visibility of the eye in this region is only one-millionth of that of the radiations strongly impressing the retina.—**Émile Haas**: New researches on the successive differential light sensibility for white light.—**L. Vellux**: Contribution to the study of narcosis. The distribution coefficient of hypnotics between water and organic solvents, particularly solvents possessing ethylene linkages.—**Jean C. Faure**: The essential factors of a biological complex —**Alfred Maubert**: The influence of thorium X on the ammoniacal fermentation.—**J. Cantacuzene** and **O. Bonciu** · The modifications undergone by streptococci of non-scarlatina origin in contact with filtered scarlatina products

Vienna.

Academy of Sciences, April 29 —**R Kremann** and **A. Trostek**: Electrolytic conduction in molten metallic alloys (xvii.) Experiments on the electrolysis of zinc with lead, cadmium, of antimony with lead and bismuth, and of cadmium with lead and bismuth — **R. Kremann**: Communication xviii. Comprehensive consideration of the results so far obtained in this series of communications.—**K. Spitzer**: On the content of ortho-dioxy-benzole derivatives in the cocoons of the Emperor moth (Saturnia).—**J. Krames**: On the degeneration of striction lines in ruled surfaces. **O. Koller**: Some new fishes from the island of Hainan. Includes a new genus of Siluridæ and a new species of Cyprinidæ.—**O Koller**: A critical review of the hitherto described central and south European species of the Cyprinid genus Barbus—**O. Richter**: On the large iron requirements of the rice plant, *Oryza sativa*.—J. Hepperger: The influence of the attraction of the earth on the frequency of meteors.—O. Dischendorfer and H. Grillmayer: Investigations in the domain of photo-chemistry (iii). On betuline.—F. Seidl: Investigations on 'self-sounding' crystals. A possibility of the transformation of electric into acoustic vibrations finding application in a telephone without diaphragm.—K. Przibram: The interpretation of the coloration of salts.

Official Publications Received.

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 521: Measurements of the Index of Refraction of Glass at High Temperatures. By C. G. Peters. Pp. 635-650. (Washington, D.C.: Government Printing Office.) 10 cents.

A Bibliography of Indian Geology, Part 4. Palaeontological Index. Compiled by T. H. D. La Touche. Pp. iv+vii+414. (Calcutta: Government of India Central Publication Branch.) 7·14 rupees, 11s. 6d.

Records of the Botanical Survey of India. Vol. 9, No. 4: Freshwater Algae from India. By Dr. Nellie Carter. Pp. 262-303+2 plates. (Calcutta: Government of India Central Publication Office.) 14 annas; 1s. 6d.

Report of the Felsted School Scientific Society for the Years 1924 and 1925. (No. 29.) Pp. 23. (Chelmsford.)

Southern Rhodesia. Report of the Director, Geological Survey, for the Year 1925. Pp. 5. (Salisbury, Southern Rhodesia.)

Union of South Africa: Department of Agriculture. Bulletin No. 2 of 1925: Some further Remarks on Tobacco Cultivation for Nicotine. By J. Vernell Cutler and J. J. Theron and J. du P. Oosthuizen. (Division of Chemistry Series No. 45.) Pp. 23. 3d. Science Bulletin No. 36: Some Experiments on the Solubility of Saldanha and Grahamstown Phosphates in the soil. By A. Stead. (Division of Chemistry Series No. 53.) Pp. 15. 3d. Science Bulletin No. 43: Some Factors influencing the Keeping Quality of Butter. By D. J. Retief. Pp. 22. Science Bulletin No. 44: A Biometrical Analysis of Merino Wools. By Prof. J. E. Duerden and V. Bosman. Pp. 16. Science Bulletin No. 46: Co-operative Fertiliser Experiments with Potatoes. By Thos. D. Hall. (Division of Chemistry Series No. 65.) Pp. 14. (Pretoria: Government Printing and Stationery Office.)

Ingeniörsvetenskapsakademien. Handlingar Nr. 43: Radio Wave Propagation. By E. F. W. Alexanderson. Pp. 10. (Stockholm: Svenska Bokhandelscentralen A.-B.) 0·70 kr.

British Museum (Natural History). Picture Postcards. Set F12: British Flowering Plants, Series No. 9. 5 cards in colour. 1s. Set F13: British Flowering Plants, Series No. 10. 5 cards in colour. 1s. Set F14: British Flowering Plants, Series No. 11. 5 cards in colour. 1s. Set F15: British Flowering Plants, Series No. 12. 5 cards in colour. 1s. Set F16: British Orchids, Series No. 1. 5 cards in colour. 1s. Set F17: British Orchids, Series No. 2. 5 cards in colour. 1s. (London: British Museum (Natural History).)

New Zealand State Forest Service. Bulletin No. 4: Monograph on the New Zealand Beech Forests. Part 1: The Ecology of the Forests and Taxonomy of the Beeches. By Dr. L. Cockayne. Pp. 71. (Wellington, N.Z.: W. A. G. Skinner.) 4s.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 62: Report on a Mission to California (U.S.A.) to study New Methods of Fumigation of Citrus Trees. By Naguib Eff. Iscander. Pp. ii+41. (Cairo: Government Publications Office.) 5 P.T.

Proceedings of the United States National Museum. Vol. 68, Art. 14: Termites collected on the Mulford Biological Exploration to the Amazon Basin, 1921-1922. By Thomas E. Snyder. (No. 2615.) Pp. 76+3 plates. (Washington, D.C.: Government Printing Office.)

Navy (Health). Statistical Report of the Health of the Navy for the Year 1923. Pp. v+140. (London: H.M. Stationery Office.) 5s. net.

Proceedings of the Royal Society of Edinburgh, Session 1925-1926. Vol. 46, Part 2, No. 17: Some Hyperspace Harmonic Analysis Problems introducing Extensions of Mathieu's Equation. By Prof. Pierre Humbert. Pp. 206-209. 6d. Vol. 46, Part 2, No. 18: The Invariant Theory of Forms in Six Variables relating to the Line Complex. By Prof. H. W. Turnbull. Pp. 210-222. 1s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Dominion of Canada. Report of the Department of Mines for the Fiscal Year ending March 31, 1925. (No. 2076.) Pp. iii+75. (Ottawa: F. A. Acland.) 15 cents.

Canada: Department of Mines: Victoria Memorial Museum. Museum Bulletin No. 40 (Biological Series No. 9): Birds collected and observed during the cruise of the *Thiepval* in the North Pacific, 1924. By Hamilton M. Laing. (No. 2072.) Pp. ii+46. 15 cents. Department of Mines: Geological Survey. Memoir 143, No. 124 Geological Series: North Shore of Lake Huron. By W. H. Collins. (No. 2052.) Pp. iii+160. 30 cents. Summary Report, 1924, Part B. (No. 2077.) Pp. 127B. (Ottawa: F. A. Acland.)

Proceedings of the London Mathematical Society. Second Series, Vol. 24. Pp. lxi+493. (London: Francis Hodgson.)

Diary of Societies.

SATURDAY, JUNE 19.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Eastern District) (at Town Hall, Stockton-on-Tees), at 10.45.—W. A. Smith: The North Tees Joint Town Planning Scheme and Notes on Stockton-on-Tees Housing Schemes.—J. P. Wakeford: Notes on Stockton and some of its Municipal Works.

MONDAY, JUNE 21.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. W. H. Lang: Contributions to the Study of the Old Red Sandstone Flora of Scotland. III. On *Hostimella (Ptilophyton) Thomsoni*; IV. On a Specimen of Protolepidodendron from the Middle Old Red Sandstone of Caithness; V. On the Identification of the 'Large Stems' in the Carmyllie Beds of the Lower Old Red Sandstone as Nematophyton.—S. Williams: A Critical Examination of the Vittarieae.—Dr. F. R. Cowper Reed: Some New Ordovician and Silurian Fossils from Girvan.—Prof. Graham Kerr: Note on the Fossil Fang of an Extinct Snake.—*To be read by title*.—J. M. Whittaker: On a Polarised Light Quantum.—Dr. W. W. Taylor: (*a*) Note on a Theory of von Weimarn; (*b*) Ferric Hydroxide and the Lyotrope Series.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—F. H. Cecil Brook: Implications of the Philosophy of Bergson.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Presentation of the Royal Gold Medal.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Summer Meeting, Scarborough) (continued on June 22 and 23).

INSTITUTION OF NAVAL ARCHITECTS (in Belgium) (continued until June 27).

TUESDAY, JUNE 22.

PREHISTORIC SOCIETY OF EAST ANGLIA (at Royal Anthropological Institute), at 2.30.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—V. Gordon Childe: The First Colonisation of Central Europe.

WEDNESDAY, JUNE 23.

ROYAL COLLEGE OF PHYSICIANS, EDINBURGH, at 5.—Dr. J. Cowan: The Failing Heart (George Alexander Gibson Lecture) (1).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. H. F. Osborn: Methods and Results of American Museum Explorations in the Gobi Desert of Mongolia (Lecture).

RADIO SOCIETY OF GREAT BRITAIN (at Institution of Electrical Engineers), at 6.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (Summer Meeting at Norwich) (continued on June 24 and 25).

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (at Bristol) (continued until June 26).

THURSDAY, JUNE 24.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.30.—Sir Oliver Lodge: The History and Development of the Telephone (Lecture).

ROYAL SOCIETY, at 4.30.—J. C. McLennan and A. B. McLay: On the Structure of the Arc Spectrum of Gold.—J. C. McLennan and H. G. Smith: On the Series Spectra of Palladium.—A. M. Tyndall and L. R. Phillips: The Mobility of Ions in Air. Part III.—L. C. Jackson: Investigations on Paramagnetism at Low Temperatures. Part II.—Sybil Cooper and D. Denny-Brown: Responses to Rhythmical Stimulation of the Cerebral Cortex.—*Papers to be read in title only*.—Karl Pearson: Researches on the Mode of Distribution of the Constants of Samples taken at Random from a Bivariate Normal Population.—Lord Rayleigh: Further Spectroscopic Studies on the Luminous Vapour distilled from Metallic Arcs.—Sir William Hardy: A Microscopic Study of the Freezing of Gel. Part I. and Part II.—Sir William Hardy and Millicent Nottage: Studies in Adhesion. I.—T. Moran: The Freezing of Gelatin Gels.—W. Jevons: The More Refrangible Band System of Cyanogen as developed in Active Nitrogen.—J. A. V. Butler: The Equilibrium of Heterogeneous Systems including Electrolytes. Part I.—(The late) Mrs. Hertha Ayrton: Primary and Secondary Vortices in Oscillating Fluids: Their Connexion with Skin Friction.—T. T. H. Verschoyle: Isotherms of Hydrogen, of Nitrogen, and of Hydrogen-Nitrogen Mixtures at 0° and 20° C. up to a Pressure of 200 Atmospheres.—E. W. Marchant and J. L. Miller: The Loss of Energy in Metal Plates of Finite Thickness, due to Eddy Currents produced by Alternating Magnetic Fields.—W. Sucksmith and H. H. Potter: On the Specific Heat of Ferromagnetic Substances.—L. B. Pfeil: The Effect of Occluded Hydrogen on the Tensile Strength of Iron.—T. E. Allibone: The Infra-red Secondary Spectrum of Hydrogen.—D. C. Rose: The Scattering of Alpha Particles through Small Angles.—V. H. Stott, D. Turner, and H. A. Sloman: Effects of Thermal Treatment on Glass as shown by Precise Viscometry.—J. E. Lennard-Jones and Miss B. M. Dent: The Forces between Atoms and Ions. II.—J. Topping and A. E. Ludlam: Tables of log $K_0(x)$ over the Range $x=2$ to $x=12$ at Intervals of 0.001.—B. Lambert and E. T. Hartley: An Investigation of the Effects of Variations in the Radiation Factor on the Efficiency of Dewar Vessels.—J. E. Lennard-Jones and W. R. Cook: The Molecular Fields of Hydrogen, Nitrogen, and Neon.—H. Florey: Observations on the Resolution of Stasis in the Finer Blood Vessels.—T. S. P. Strangeways and Honor B. Fell: Experimental Studies on the Differentiation of Embryonic Tissues growing *in vivo* and *in vitro*. II. The Development of the Isolated early Embryonic Eye of the Fowl when cultivated *in vitro*.—Nesta Ferguson: The Aloinae—a Cytological Study, with especial reference to the Form and Size of the Chromosomes.

ROYAL COLLEGE OF PHYSICIANS, EDINBURGH, at 5.—Dr. J. Cowan: The Failing Heart (George Alexander Gibson Lecture) (2).

OPTICAL SOCIETY (at the Imperial College of Science), at 7.30.—M. von Rohr: Joseph Fraunhofer and the Development of Optical Instruments.

FRIDAY, JUNE 25.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.

DIESEL ENGINE USERS' ASSOCIATION (at Caxton Hall, Westminster).—J. H. Stackford: Some Deleterious Properties of Lubricating Oils.

SATURDAY, JUNE 26.

BRITISH PSYCHOLOGICAL SOCIETY (at University College, Gower Street, London, W.C.1), at 3.—Prof. C. Spearman: The Passing of the Psychology of 'Shapes' (*Gestalten*) into that of 'Wholes' (*Ganzheiten*).—Rex Knight: Modern Theories of the Self.

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Science, Industry and Education.

THE relationship of science to industry is a subject that has been frequently discussed in these columns, and if we return to it once again it is because as time goes on we recognise more and more that industry without science is like a ship without a rudder, a thing that drifts hopelessly on the ocean of reality. Although we stand in the first place for culture—a knowledge of the best that has been thought and done in the world—we cannot overlook the fact, so abundantly proved by history, that nations of the highest culture become ready preys to the forces of barbarism and disorder when knowledge and attainments cease to maintain adequate connexion with the material realities of life, when capacity for action is "sicklied o'er with the pale cast of thought." Science has its idealistic side no less than religion, art, and morals, and its dominion should be coterminous with theirs in extending over the whole range of human activities: its content touches human life at a multitude of points, and its method is capable of almost universal application. Nevertheless, we have to realise that the battle of life is still fought mainly below the belt, and therefore we must look to science to play its part, not only in shifting the arena from the lower levels of brute force, cunning, and cupidity to the higher ground of truth, justice, and regard for posterity, but also in helping us to conquer in the fight as it is fought to-day.

Great Britain needs the help of science in a peculiar degree. Over-population, combined with neglect of agricultural possibilities, has forced us to rely for our material existence upon imported products, and these have to be paid for mainly by exporting manufactured goods. We have few, if any, closed markets, and success depends upon the high quality or novelty of our wares, and upon industrial organisation, all of which are dependent upon science. What progress are we making in promoting science and its application to industry and national life?

Apart from the valuable work which was done by the Government committee appointed to inquire into the teaching of science in our secondary schools, and that which is being done under the Department of Scientific and Industrial Research, we see few signs of progress. Disregarding exaggerated statements, we believe that the progress of science teaching in secondary schools has fallen below expectations, and that the methods pursued in our universities and technical colleges still leave something to be desired. From the point of view of science, the popular Press remains in the throes of barbarism, and literary men speak openly, if foolishly, of "the bankruptcy of science."

The chief cause of this unsatisfactory state of affairs is ignorance, and the chief remedy is organised, concerted action to popularise the teachings of science; to bring home to the layman what science has done for mankind in the past, the nature of the problems awaiting solution, and what science may do, if adequately supported, in the future.

Alone among scientific organisations, the British Science Guild and the British Association have done valuable work in disseminating scientific knowledge among the people, and their present efforts to establish a publicity service, similar to Science Service in the United States, are worthy of every encouragement and support. The collection, preparation and distribution of interesting and accurate notes and articles upon scientific subjects likely to be accepted by the public Press is, however, too great a burden for such voluntary organisations to bear unsupported, and, the question being one of national importance, it seems right that a Government which expends nearly 50,000,000*l.* annually on education —not reckoning the 30,000,000*l.* contributed from rates—should contribute towards the cost. In addition to a scientific news service, we need popular accounts of researches that have led to new knowledge, and more especially of those which have resulted in new developments or improvements in industry, transport, and public health.

The co-operation of the Department of Scientific and Industrial Research would be particularly desirable in this connexion. The publications of this Department are well known to and much appreciated by scientific workers; but they are not addressed to the layman or written in a style to attract him, and the more learned communications that occasionally see the light in the transactions of societies are even less suitable for the purpose. It is essential that the subject matter should be written up in an attractive style, as free as possible from technical terms, due regard being given to the human element Experience having shown that, as a rule, the research workers and inventors are ill-fitted to describe their work in a manner understanded by the people, the writing should be done by those who have the gift of popular exposition, though the materials therefor should, when possible, be supplied, and the manuscripts revised, by the discoverers. An interesting development in this direction is the publication in the United States of Popular Research Narratives, collected by the Engineering Foundation of New York. The two volumes of "tales of discovery, invention, and research" that have been issued to date are excellently got up, and though many may think that they err on the side of brevity and 'scrappiness,' there is no doubt that the mode of presentation is good and that the writers and publishers will succeed in their attempt to interest the public.

It may be objected that, owing to the short period during which the Department of Scientific and Industrial Research has been in active existence, the results so far obtained are too meagre for the purpose we have in view; nevertheless, we believe that the twenty or so research associations, and national institutions like the Medical Research Council, the National Physical Laboratory, the Fuel Research Station, and Rothamsted, could provide between them an abundance of material; and if matter ran short, the wealth lying dormant in the records of learned societies, and in certain reports of Government Commissions, could easily be tapped. Another likely objection is that the publication of results of research in applied science would be against the interests of the manufacturers who subscribe to the research associations.

The answer to this contention is that it is nearly always possible to write a broad general account of a discovery or invention without disclosing important details of manufacture. Success in manufacture depends more often than not upon important details of plant or method of operating. True, but the public is not interested in such details; and, if necessary, the manufacturer can usually protect himself by letters patent. The manufacture of sulphuric acid by the contact process necessitated long years of work and a large expenditure of money before it was made a commercial success, yet the process was described at an early date in the columns of the *Berichte* with all the detail that even a scientific man desires; and similar statements could be made of many other processes, including those of Birkeland and Eyde, Franck and Caro, Haber, and Claude for the fixation of atmospheric nitrogen. In spite of assertions to the contrary made during the War, undue secrecy continues in our midst to the manifest disadvantage of the cause of science.

Another educational problem demanding attention is the training of science students who are destined for industry. In his Streatfeild memorial lecture (NATURE, December 12, 1925, p. 876), Mr. F. H. Carr, now president-elect of the Society of Chemical Industry, condemned the present training of chemical students for being too stereotyped: too much stress is laid upon training in research and too little on fostering ability to apply scientific knowledge to works' processes; there are many types of student-mind and many fields of possible application, yet we persist in casting all our material in the same mould. Prof. A. W. Crossley expressed the same view in his recent presidential address to the Chemical Society, likening the teacher of chemistry to the manufacturer who persists in offering to foreign customers the goods he thinks they ought to want, rather than those for which they actually ask. The main types of chemist required in industry, Prof. Crossley points out, are the research worker, the equally important man who can apply new scientific data to industrial development, the chemist to control works' processes and undertake, or supervise, analytical work, and the chemical engineer. Each of these types requires in the first place a broad general training in, say, three sciences before specialisation is allowed, but thereafter the training must be adapted to the future career: the 'pure' chemist, the industrial chemist, the school or university teacher, each requires a different curriculum.

The blame for the present inadequate or misdirected training is not, however, entirely the teacher's; the manufacturer is also culpable in not making clear his wants, or making the fulfilment of those wants into practical possibilities. Last year, in commenting upon Prof. Wynne's address to the Chemical Society (Nature, August 8, 1925, p. 195), we expressed the hope that manufacturers would devote attention to this matter, and we are now pleased to learn that, following the lead given by Sheffield, the British Dyestuffs Corporation has initiated a scheme whereby students may gain practical experience in its works during the long vacation. The result from the students' point of view, Prof. Crossley states, has been an unqualified success, and we do not doubt that the advantages will be mutual, for such vacation courses should afford the manufacturer excellent opportunity to select promising personnel for future employment.

We hope that this movement will spread, not only in the chemical industry, but also in the large and virgin field of applied physics. It is a happy omen that the demand in industry for trained physicists is considerably in excess of the supply. In the past, physicists as well as chemists have been trained too exclusively on academic lines, as if they were all to become teachers or 'pure' research workers. Important as these callings are, we are inclined to agree with the critics that an adequate supply of men whose special faculty lies in the application of scientific knowledge to industrial problems is at least of equal moment. Such men, it may be said, are born and not made; yet, if we believe in education at all, we must look to the universities and technical colleges to discover where this special ability is latent, and, knowing the needs of the manufacturer, to nurture it in the most fruitful way.

Modern Views on the Origin of Birds.

The Origin of Birds. By Gerhard Heilmann. Pp. vii+208. (London: H. F. and G. Witherby, 1926.) 20*s.* net.

Divergent views on much contested problems are often traceable to some rash statements, the authors of which were scarcely aware of there being involved some serious problem.

Numerous fossil three-toed footprints of obviously bipedal creatures were discovered about 1835 in the Triassic sandstone of Connecticut, and described by E. Hitchcock as Ornithichnites, bird-tracks. According to their size and configuration, which is all we know of their owners, various generic and specific names became assigned to them. Ch. L. Bonaparte (1856) combined these Ornithichnitidæ with the dodo, the subfossil Aepyornis, and the Eocene Gastornis as Inepti, a subgroup of his order Columbæ. A curious jumble of ineptness and sense.

Serious speculation about the origin of birds arose with the discovery (1860) of the famous Archæopteryx, from the upper Jurassic oolite of Solnhofen, near Eichstaedt, north-west of Ingolstadt, Bavaria. This specimen, now in the British Museum (Natural History), was first described by A. Wagner as Griphosaurus, "a reptile with bird's feathers." R. Owen monographed it (1863) as *Archæopteryx macroura*, "a bird with certain embryonic features" W. K. Parker (1867) published valuable remarks "On the relations of the Bird to the Reptile." Haeckel ("Generelle Morphologie," 1866) divided the birds into Saururæ (Archæopteryx) and Ornithuræ. T. Huxley, in his famous classification of birds (1867), retained the first name as Saururæ, but rightly discarded the Ornithuræ, dividing these with Merrem (1813) into Ratitæ and Carinatæ, and in his "Manual" (1871) he was the first to summarise clearly and concisely the descent of birds from reptiles, hence his term Sauropsida.

A second, much better preserved specimen, now in Berlin, was discovered (1877) also near Eichstaedt; first described and discussed by C Vogt (1879) as "an intermédiaire entre les oiseaux et les reptiles." It has been exhaustively monographed by W. Dames (1884).

Heated discussions arose whether Archæopteryx was a direct forerunner of the Carinatæ, or merely a lonely offshoot, or last but by no means least, a true intermediate link or 'Schaltform' between reptiles and birds, a view which was disallowed by the Prussian Government. Dames added some further detail of the limb girdles in 1897; but both specimens remained otherwise undisturbed until, in 1917 and after, Petronievics persuaded the authorities to expose them. He distinguished the Berlin specimen as *Archæornis siemensi.*

Meanwhile (1875) zoologists had been startled by O. C. Marsh's discovery of birds with numerous teeth from the mid-Cretaceous of Kansas. They were sumptuously monographed as Odontornithes (1880), this new subclass to contain the large flightless aquatic Hesperornis, the well-flying Ichthyornis and Archæopteryx. Later considerations showed, however, that they were only a heterogeneous assembly, in fact that probably all birds had retained teeth unto the end of Cretaceous times.

Although Marsh himself emphasised the undoubted affinity of Hesperornis with the recent diver-grebe group, he also took the complete absence of a keel in the flat sternum as indicating close relationship to the Ratitæ. Dollo (1881) took up this idea and with merciless logic united Hesperornis with the Ratitæ proper, calling the former "une autruche carnivore aquatique," a nightmare which, thanks to a popular article by Wiedersheim, became a "schwimmender Strauss" and "swimming ostrich."

Dollo was probably instigated by P. Albrecht, an erratic genius who discovered the so-called fourth, or inner, distal, trochanter of Hesperornis, Iguanodon, and traceable in ducks, a coincidence which led him to say that iguanodon also was a swimmer. Thus it came to pass that the dinosaurs were roped in with the Ratitæ, and the Triassic ornithichnites were taken as welcome proof of the necessary great age of the whole assembly. This incredible muddle went so far that moas, cassowaries, kiwis, ostriches were, not in popular literature alone, looked upon as the direct survivors of some suitable dinosaurian side-branch, whilst the much later Archæopteryx was the progenitor of the modern flying birds.

The literature bearing upon the problematic origin of birds has assumed great dimensions. Within the last few years the most noteworthy serious contributions have been made by a Dane, a Swiss, and a Serbian. Their several publications overlap each other.

H. Steiner of Zurich (1917) settled the vexed question of the remiges ("Problem der Diataxie der Vogelextremität," *Jena Zeitschr.*). In 1922 followed a renewed study of the development of the wing-skeleton, a work not yet fully appreciated which will revolutionise our hitherto very faulty knowledge ("Ontogenetische und phylogenetische Entwicklung des Vogelflügelskelettes," *Acta zoologica*, Stockholm, 1922). By careful, well-illustrated comparison with recent and extinct reptiles, he concludes these birds form one great natural assembly with dinosaurs, crocodiles (including the ancestral Para- and Pseudosuchia), and the aberrant pterosaurs, all of which agree, unlike all other reptiles, by the preponderance of the sharp-clawed 1st to 3rd finger, while the 4th and 5th steadily tend to reduction; indicating undoubtedly arboreal, climbing adaptation. This view he justifies by good argumentation. It applies also to the presumable common ancestor. Crocodiles proper have, of course, taken to aquatic life in a tertiary way, while others, like dinosaurs, have descended or returned to the primary terrestrial, tetrapodal, and eventually bipedal life.

Comparison of dinosaurs with Ratitæ reveals no direct ancestral relationship. Therefore dinosaurs can be compared only with birds which did fly, and Archæopteryx, the sole available material, dates from a time when these reptiles were already too far pledged. Both classes produced the most surprising convergences, but these occur crosswise, mutually contradicting relationship; for example, this bird's foot agreeing most with that of some of the Saurischian division of the dinosaurs, whilst the bird's pelvis agrees most with that of the Ornithischian division, namely, iguanodonts.

Exaggeration of the still very imperfectly known differences between the London and Berlin Archæornithes and comparison with Struthio only, to the utter neglect of all the other modern Ratitæ, led Petronievics to the following surprising conclusions (B. Petronievics and A. S. Woodward, "Pectoral and pelvic arches . . . of Archæopteryx," *Proc. Zool. Soc.*, 1917; B. Petronievics, "Über die Berliner Archæornis, Genf. 1925" (Reprint of *Ann. Géolog. de la Péninsule Balcanique*, Belgrade, 1924)). The Archæornithes (the reviewer's term, 1893), still without a keel, diverged already in Jurassic times, so that (at the same place and time, in the lithographic slate) Archæopteryx as the Ur-Ratite founded the teethed Ratite Hesperornis and the toothless modern Ratites.—Archæornis produced the toothed Carinates, for example Ichthyornis, and all the toothless modern Carinates. This scheme he calls "a rational classification based upon strictly morphological characters, and further explanation unnecessary."

The common ancestor, the Protornis or Proavis, could fly, but had not yet a keel. Its immediate ancestors were the Protoherpornithes (the reviewer's Herpetornithes, 1893), which were covered with down only! This "eidechsenartiger Urvogel" arose from some primitive group of the Lacertilia. (He does not mention Steiner's work.)

Now, if there is anything proved by Fürbringer and others, "it is that what we call Ratitæ (namely, ostriches, cassowaries, kiwis, etc.) are the direct descendants of birds which have lost the power of flight; therefore also lost the keel, a reduction which is still happening to various Carinates, which even if losing all power of the keel could thereby never become Ratitæ, because these have retained other important ancestral characters no longer existing in modern

Carinates. The same complicated process has happened long before ostriches became flightless, a consideration which led Fürbringer in his elephantine work to invent the staggering terms of Proto-Deutero-Trito-Apteornithes. Originally no feathered bipeds had a keel, but we must not be hypnotised by this deficiency lest we relapse into the belief in the "swimming ostrich" of fifty years ago.

G. Heilmann's carefully composed and extremely well illustrated book appeared first in Danish as "Fuglenes Afstemning," several instalments of which appeared in *Dansk Ornithol. For. Tidskr.* 1913–15, and an English version has now been prepared. More than half of the work contains the countless embryological and anatomical agreements of reptiles and birds and an exhaustive description of Archæopteryx; a good introduction for those who are not well acquainted with the subject. By reasoned elimination he restricts the possible ancestors of birds to the pterosaurs, predentate or ornithischian dinosaurs, cœlurosaurs, and pseudosuchia. The first group he disposes of easily.

The predentates, for example iguanodonts, present difficulties, but in spite of all resemblances these dinosaurs are found wanting. Perhaps by discarding their pelvis he protests too much, because the pelvis problem will not be solved without the hypothesis that it is fundamentally a polymetameric compound; further, the so-called pectineal process may be either entirely iliac or prepubic or both, according to the origin and extent of the ambiens muscle. The author feels convinced that this process of birds is iliac, therefore not the homologue of the reptilian prepubis. By thus ingeniously getting rid of the predentates he turns to the older group, the cœlurosaurs, which fascinate him by their cavernous vertebræ, a feature which he wrongly connects with the pneumatic skeleton of birds.

Concerning the forelimb the author closely agrees with Steiner (cf. Fig. 19), whom he does not mention. But even these creatures are not to be trusted, since their strong birdlike resemblances may be analogous adaptations. Thus he narrows the possible ancestry to the Pseudosuchia, which as probable ancestors of the theropodous dinosaurs and cœlurosaurs seem to possess in their still generalised condition all the necessary material and trend for future birds, as notably the structure of limbs, girdles, and skull. The final result is the origin of birds traced well into the Trias to the common ancestor of the archosaurian division of reptiles, in close agreement with Steiner.

For the impetus to flight Heilmann prefers with Abel and Steiner the arboricolous climbing life which encouraged jumping from branch to branch, and thus parachuting by patagia and enlarged feathers. Not Baron Nopcsa's dinosaur which gets the necessary momentum by running; nor does our author favour Beebe's 'Tetrapteryx,' although on p. 199 his own restoration of the Proavis shows no less than four or five feather parachutes. Those which forsook the trees and took to ground life specialised increasingly as runners.

The frontispiece, by the author, gives a charming picture of a loving couple of Archæornis, she of demure look and garb, he in full dress of brown, white, and—beautiful blue! H. GADOW.

More Relativity.

(1) *The A B C of Relativity.* By Bertrand Russell. Pp. v+231. (London: Kegan Paul and Co., Ltd.; New York: Harper and Bros., 1925.) 4*s.* 6*d.* net.

(2) *The Einstein Theory Explained and Analysed.* By Samuel H. Guggenheimer. Pp. ix + 326. (New York: The Macmillan Co., 1925.) 10*s.* 6*d.* net.

POPULAR accounts of the theory of relativity continue to appear, and one must presume from this that public interest in the subject has by no means died out. Writers at this time of day, however, are under an obligation which did not burden early expositors, in that they have to justify their intrusion into an already overcrowded field. However unsuccessful existing literature may have been in making the new ideas clear (the fact that interest in the subject is still maintained shows that a considerable measure of success must have been attained), the mere accumulation of volumes directed towards the same end is in itself an evil quite independent of the intrinsic worth of the volumes themselves. Too many cooks, though they be all masters of the gastronomic art, will nevertheless spoil the broth. Mr. Russell justifies his attempt on the ground that previous popular accounts of relativity "generally cease to be intelligible just at the point where they begin to say something important." Mr. Guggenheimer offers no apology, but breaks new ground by providing, not an account of the theory, but a critical examination of the manner of exposition which he finds in the English translation of Einstein's own popular book. It is extremely doubtful whether the motive is in either case a sufficient justification of the result.

(1) Mr. Russell, however, has written an extremely readable and lucid book, the substantial accuracy of which, of course, goes without saying. Perhaps its most characteristic and helpful feature is the excellence of the verbal illustrations which occur frequently and most of which are quite new. The chapters dealing with the relativity of time—the most difficult aspect of the subject to the beginner—are particularly clear, and the author is commendably precise in stating the possibilities of arranging events in a time order. The

widespread vague notion that, on the relativity theory, any event may be either before or after any other event, according to the time-system used, is effectively dispelled.

The choice of a title is not a happy one. It suggests the alphabet of the subject, which is of very little use to any one who does not intend to become a physicist. What Mr. Russell has actually presented is a much more valuable thing; namely, the *meaning* of relativity. He has rightly concentrated attention on the revolution in our concept of Nature which the theory brings about, and dealt effectively with the problem of separating, in our world of experience, the parts which belong respectively to external events and to the observer. The chief defect of the book seems to be the lack of any obvious connecting thread running through the whole. The reader who is able to follow each chapter quite clearly may be left at the end quite incapable of forming a definition of relativity suitable for a dictionary. As a particular example of this apparent disorder may be cited the discussion of 'force' in Chapter xiii. which harks back to a point already clearly raised and to some extent dealt with in Chapter viii. On the whole, however, Mr. Russell's book is certainly among the best popular accounts of relativity which have appeared.

(2) Mr. Guggenheimer's book, as has been said, is not an exposition of the theory at all, and its title is misleading. The author is confessedly neither a mathematician nor a physicist, and it is clear that he is not an astronomer. He approaches the subject from the metaphysical side, and subjects a number of passages of Einstein's elementary treatise to minute dissection. To the reviewer, who finds Mr. Guggenheimer's work far less intelligible than that of Einstein, he appears to introduce difficulties into Einstein's exposition and then to devote a considerable space to their elucidation. For example, several pages are occupied with a discussion of whether Einstein, in speaking of 'absolute' as contrasted with 'relative' motion, is "attempting to penetrate the noumenal world" and becoming involved in "an ultimate, absolute, and infinite First Cause."

The book may appeal to those who delight in mental gymnastics and are indifferent to the meaning of scientific relativity, but those who wish to understand Einstein's theory should carefully avoid it. The citation, with examples, of two defects will suffice to reveal its danger—the scientific statements are vague, and they are often inaccurate. As examples of vagueness we give two typical sentences: "All matter consists, in the last analysis, of one substance or energy in different conditions of electric charge or force" (p. 38). "Although body A may be at rest relative to body B, from which A appears to be moving, to an observer on B it will be A which appears to move, and neither is actually moving" (p. 167). Examples of inaccuracy are abundant in the very biassed discussion of the tests of the relativity theory. Thus, the existence of an intra-Mercurial planet is said to be "highly probable," and the deflexion of light by a body is said to increase with its radius, because a large radius "gives the force a longer time to exercise its accelerating pull upon the fast passing light." The author appears to have some power of thought and expression, which should be concentrated on a subject with which he is better acquainted.

H. D.

A New Brunswick Geologist.

Loring Woart Bailey: the Story of a Man of Science. By Joseph Whitman Bailey. Pp. 141+12 plates. (St. John, New Brunswick: J. and A. McMillan, Ltd., 1925.) n.p.

IN this volume we are presented with an interesting life-history of one of the earliest leaders of scientific thought and education in the Maritime Provinces of Canada. In his scientific work, Dr. Bailey was closely associated with Dr. G. F. Matthew and rendered notable service to Dawson, Logan, and Selwyn in the earliest researches on the geology of what was then an unknown region. But he will perhaps be best remembered as having been for nearly half a century an active member of the faculty of the University of New Brunswick and as one of the little group of men who nurtured the Natural History Society in its infancy.

One of Dr. Bailey's ancestors sailed from England in the good ship *Angel Gabriel*, built for Sir Walter Raleigh. The ship was wrecked near Bristol, Maine, in 1635, but John Bailey survived. His descendant, the subject of this biography, was born in 1839 at West Point and was educated in the United States, but when he was not yet twenty-two years of age accepted an offer of a professorship at the University of New Brunswick at Fredericton. The appointment was opposed on the ground of his alien birth and extreme youth, but Bailey survived to become one of the leading figures of the institution. Here he built Sunnyside in open fields extending to the banks of New Brunswick's great river, and extended hospitality to many old friends, amongst others to his old pupil, the late Sir George Parkin.

After the publication of the "Origin of Species" the more aggressive types of scientific men and theologians commenced an acrimonious discussion, which is still liable to blaze. Dr. Bailey had sufficient tact to remain in harmony with both sides and was consulted by laity and clergy alike on scientific questions. In 1907, after forty-seven years' service, he retired, held in the highest esteem by the students as well as by members of the faculty.

Dr. Bailey's scientific researches related to the Maritime Provinces. He was greatly interested in diatoms, but his more important work, done in association with Dr. Matthew, lay in collecting the fossils and determining the age of the geological formations of an unknown region. Within 15 miles of St. John he recognised representatives of formations ranging in age from Lower Laurentian to Trias. The work was commenced as a labour of love, but was continued from 1867 as a part of the programme of the Geological Survey. In 1913 Dr. Bailey acted as scientific guide to one of the excursions of the International Geological Congress. To one at least of that party his intimate knowledge of the geology of Albert, St. John and Victoria came as a revelation of what could be accomplished in unsympathetic surroundings. He died in 1925 in his eighty-sixth year.

A. S.

Magnetism.

Modern Magnetics. By Prof. Felix Auerbach. Translated by H. C. Booth. Pp. vii + 306. (London: Methuen and Co., Ltd., 1925.) 15*s.* net.

THIS work gives an admirable account of all the older work on magnetism. It does not assume much knowledge to start with, and without using much mathematics it takes the reader on to quite advanced subjects. The style is pleasant and easy—with perhaps a touch of the rather glutinous brightness of the German journalist. The book will be of value to many who already claim considerable knowledge of the subject.

The student who has worked out examination questions on magnetism has the impression that he understands all about magnetic force and magnetic induction, and that all that is necessary is to multiply together the mystical letters H and μ to get the still more mystical B. The present work will disabuse him of this impression and will replace it by a wholesome respect for the difficulties to be faced, both theoretical and practical. In this connexion it is really a pity that induction and permeability play so large a part in the mathematical text-books, for, in fact, magnetisation and susceptibility are not only more primitive ideas, but also are much more useful in the study of magnetism itself, especially in the case of ferromagnetism.

The volume claims to deal with the whole field of magnetism, and it is disappointing to find that a work published in 1925 makes no mention of an experiment of such fundamental importance as the Stern Gerlach experiment, which directly exhibits the magnetic moments of atoms. The German original came out in 1921, which would explain this omission, but it would not justify the absence of any account of the almost equally important gyromagnetic effects and of, at any rate, the earlier of the recent developments of the theory of the Zeeman effect. Indeed, it is a little surprising to find the name "Modern Magnetics" applied to a book containing a bibliography—and a very full one—with no reference to work later than five years before its publication in German, and nearly ten years before the translation.

It is a great pity that a supplementary chapter or two has not been added so as to bring the account a little more closely up-to-date. Still, this is perhaps a tribute rather to the rate at which the subject has developed than a criticism of the content of the book—which may be very strongly recommended to any one wishing to acquire a knowledge of the more classical parts of the theory of magnetism.

Our Bookshelf.

Contemporary British Philosophy: Personal Statements. (Second Series.) By James Ward, E. Belfort Bax, Douglas Fawcett, G. Dawes Hicks, R. F. Alfred Hoernlé, C. E. M. Joad, G. E. Moore, J. A. Smith, W. R. Sorley, A. E. Taylor, J. Arthur Thomson, Clement C. J. Webb. Edited by Dr. J. H. Muirhead. (Library of Philosophy.) Pp. 365. (London: George Allen and Unwin, Ltd.; New York: The Macmillan Co., 1925.) 16*s.* net.

THE twelve contributions contained in this volume cover a very wide field and are naturally unequal in value. Some writers attempt a sketch of a complete philosophy, while others deal with special problems. The first place is given as a "tribute of respect" to the article by the late Prof. James Ward, which, as the editor tells us, may be looked upon as Prof. Ward's "last will and testament to his contemporaries on the subject of general philosophy." The function of the latter he takes to be to understand experience as a whole, "to find a unity and meaning in the entire sum of things, beyond the so-called system of nature as science conceives it." His general position is well indicated in the title of his article, "A Theistic Monadism." It owes much to Kant and Lotze, and especially to a lifelong study, of great penetration and insight, of the natural sciences; though, as he points out, he has often been, strangely enough, accused of 'attacking' and 'reviling' them.

The view of philosophy as synoptic is also taken by other contributors, notably by Prof. R. F. A. Hoernlé and by Prof. J. Arthur Thomson. On the other hand, Prof. A. E. Taylor takes a more modest view of the nature of metaphysical speculation, the object of which, according to him, is not the unification of the sciences, but "the necessarily imperfect and tentative reconciliation of the exigences of scientific thinking with the imperative moral and religious demands of life." He devotes his article to a study of "The Freedom of Man," and gives a spirited defence of indeterminism and real contingency as involved in the moral life of man. Stress is also laid on moral values by Prof. W. R. Sorley, who seeks to bring out the bearing of the objectivity of value upon central metaphysical problems.

On the side of epistemology the most noteworthy articles are those of Prof. G. E. Moore on "A Defence of Common Sense" and of Prof. G. Dawes Hicks entitled "From Idealism to Realism." The latter gives a lucid account of the main principles of a realistic theory of knowledge at which he has been working for many years. His central position is that cognition is of one character through all its forms, and consists essentially in an act of judging, and that the primary function of discriminating, comparing and relating is present from the very beginning of cognitive apprehension.

In an interesting preface the editor points out the chief directions in which, despite apparent conflict and opposition, contemporary thinkers tend to approximate to one another and to arrive at common results.

M. G.

Industrial Electricity. By Prof. Chester L. Dawes. (Electrical Engineering Texts.) Part 2. Pp. xv+480. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 13*s.* 9*d.* net.

The great progress that has been made in recent years by electrical engineers in the application of theory to their craft is well illustrated by this volume. When alternating currents are employed the use of polyphase systems is almost universal, the principal exception being a few single-phase railways. One advantage of the polyphase system is the steady torque produced on the generators and motors, it being analogous to a multicylinder petrol engine. In the chapter on transmission and distribution we were interested to find that the author sometimes uses 'earth' and sometimes 'ground.' The former word is everywhere used in Great Britain and the latter is practically always used in the United States. The importance of keeping down earth currents in tramway systems is pointed out. The first method given is to use good bonds between the rails, and the second is to induce the gas and water companies to insert occasional insulating joints in their pipes. We are told that in some American cities the voltage drop along the rails must not exceed 15 volts. In Great Britain the maximum permissible drop is 7 volts, but series dynamos (negative boosters) are generally used to keep down the pressures at various points of the track. The chapter on photometry is good. We are glad that the author does not strive to use different symbols for all the various quantities he discusses. He uses I both for current and candle-power.

The chapter on electron tubes (vacuum tubes or thermionic valves) will be very helpful to the older engineers, excellent descriptions being given of the three-electrode valve, regeneration, power valves, carrier waves, and broadcasting apparatus. Modern methods of wiring buildings for the electric light are next described. Supply pressures of 300 volts are mentioned. In England 240 volts is the maximum, and in Europe much lower pressures are often used. A useful collection of 260 problems is added, telephone relays and loud speakers replacing the carbon lamps and tangent galvanometers of an earlier generation.

Transformers for Single and Multiphase Currents: a Treatise on their Theory, Construction and Use. By Prof. Gisbert Kapp. Third edition, revised by Reginald O. Kapp. Pp. xi+391+11 plates. (London: Sir Isaac Pitman and Sons, Ltd., 1925.) 15*s.* net.

The late Prof. Kapp prepared the second edition of this book in 1908. He pointed out that "during the last twelve years enormous improvements have taken place in the construction of transformers." He also said that transformers so large as 1000 kilowatts have been constructed. His son in this edition says that single transformers up to 60,000 kilowatts, or better 60,000 kilovolt-amperes, are in service and testing transformers have been built which give a million volts. The tendency towards the centralisation of power supply during the last eighteen years has become very marked and the electric output has vastly increased. Remembering that most of the electrical energy generated passes through two transformers at least, the capacity of the transformers installed in Great Britain at present must be very great. The trend of development during recent years has been to pay far greater attention to the problems of economical manufacture and mechanical construction and to improving the insulating materials employed.

The book is intended for electrical engineering students and for the engineers of supply stations. More space is devoted in this volume to points of construction, installation and maintenance. Much of the matter dealing with the general theory of electrical engineering has been omitted, and also descriptions of devices which are now obsolete. Examples of the latest types of transformers by well-known makers are fully described. The book will be found helpful by practical engineers.

Manual of Injurious Insects. By Prof. Glenn W. Herrick. Pp. xxi+489. (New York: Henry Holt and Co., 1925.) 4.50 dollars.

The author of this book, who is professor of economic entomology at Cornell University, remarks in his introduction: "It is hoped that the book may be useful to the teacher and to the student of economic entomology; and that it may serve as a reference book to any one interested in the activities, injuries and control of the more common injurious insects of the United States." It should fulfil all these hopes to a greater or lesser degree, since it is accurate, clearly and concisely written, well illustrated, and has sufficient references to guide its readers to sources of fuller information. The various pests are dealt with under the plants which they affect, while there are also chapters on pests of live-stock and of the household, but forest insects are, for some reason, omitted.

The book presents certain features not usually found in works of this character. First, there is a pleasing absence of most of the time-honoured illustrations that have done duty in almost every book on the subject for the last twenty years; more recent and often original figures have been utilised. Secondly, there are more than 100 small maps showing the distribution in the United States of each of the major pests for which trustworthy data are available. Thirdly, there is some account (although brief) of the control of pests by biological methods. The book will doubtlessly prove of service in Canada as well as in the United States, and, it may be added, a considerable number of references to the literature of Canadian economic entomology are included. A. D. I.

Phototopography: a Practical Manual of Photographic Surveying Methods. By Arthur Lovat Higgins. Pp. xv + 130 + 9 plates. (Cambridge: At the University Press, 1926.) 6*s*.

This book describes, clearly and concisely, the theory and practice of ground photo-surveying. Surveys carried out by this method suffer from two serious disadvantages. There will always be some 'dead ground' which has not been surveyed, and plotting a map from photographs is such a long and complicated process that the time gained in the field is usually lost in the office. The plotting and drawing are much simplified by the use of a stereoplanigraph, but this machine is very expensive, and few survey establishments can afford to purchase it.

Ground photographs have been used for the surveys of mountainous areas in Canada, but the method has not hitherto been employed in other parts of the British Empire. A photographic survey of Kashmir will be carried out by the Survey of India this year, and the most modern instruments and methods will be thoroughly tested. Future developments will depend upon the experience gained in Kashmir. Meanwhile, this book can be recommended to all who are interested in the subject. The stereoplanigraph is not described in detail. For this a separate volume would have been required, for the instrument is as complicated as it is expensive.

It is to be hoped that as the methods develop some simplification of the technical terms may be found possible, and that words such as 'stereophototopography' may be allowed to die a natural death.

Psyche: the Cult of Souls and Belief in Immortality among the Greeks. By Erwin Rohde. Translated from the eighth edition by W. B. Hillis. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xvi + 626. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Ltd., 1925.) 25*s*. net.

Rohde's "Psyche" marked a turning-point in the study of comparative religion when it first appeared in 1893; it has become a classic, and has been through eight German editions without change since the premature death of the author in the interval between the second and the third. Now it appears in a carefully translated English version, with the notes transferred to the end of each chapter, and the appendices to the end of the volume; a practice deplored by Rohde himself, but a great improvement in a book which appeals quite as much to the 'general reader' as to the specialist.

The translator has done another considerable service in revising the whole of the references to ancient authors, whom Rohde used to cite from the edition nearest his hand as he wrote. Only one other thing he might have done with advantage, namely, to record the pagination of the first German edition, by which Rohde's earlier critics quoted him. How convenient this is, in a book of this sort, those who have used the later German editions know. Rohde's chapters are long, and not divided into sections. But the main thing is to have an English version of Rohde's work at all, and it should be widely appreciated.

Lehrbuch der Pflanzenphysiologie. Von Prof. Dr. S. Kostytschew. Erster Band: *Chemische Physiologie.* Pp. vii + 567. (Berlin: Julius Springer, 1926.) 24 gold marks.

This first volume of a new plant physiology, hailing from Leningrad, is of quite exceptional interest. The citation of literature is exceedingly full and complete, and in many cases the references to Russian literature deal with work which is very little known in Great Britain. Thus Russian work upon the colourless chromogen, leucophyll, said to precede chlorophyll during development in the dark, and Russian work upon the nutrition of flowering plants when grown under sterile soil conditions, is somewhat fully referred to. This first volume, recognising that the modern botanist requires a critical chemical equipment, deals with the processes of metabolism from a chemical point of view and commences with an introductory chapter upon the fundamental chemical questions involved in interpretations of plant physiology.

In the second volume, problems of the entrance and translocation of solvents and solutes are to be dealt with, together with problems of growth and plant movements, and also tissue differentiation and correlations.

The Physiology of Plants: the Principles of Food Production. By Prof. G. J. Peirce. Pp. x + 363. (New York: Henry Holt and Co., 1926.) 3 dollars.

This is a somewhat discursive treatment of some of the main problems of plant physiology, particularly nutrition, water movement, respiration, and irritability. These problems are handled more fully than they would be in an elementary text; on the other hand, neither the necessary physics and chemistry, nor the essential physiological considerations, can be said to be handled thoroughly, whilst there is considerable repetition arising from the discursive nature of the book. Many readers may find the author's viewpoint interesting, however, even when he is traversing familiar ground. Thus the human and industrial contacts of plant physiology are often emphasised, and a considerable amount of recent work is discussed from an individual and, to some extent, a critical point of view.

Laundry Chemistry: a Short Handbook on the Chemistry of Laundry Materials and Methods. By A. Harvey. (Lockwood's Manuals.) Pp. viii + 116. (London: Crosby Lockwood and Son, 1926.) 4*s*. net.

This book contains brief accounts of those parts of chemistry which are involved in laundering processes, with a short introduction to elementary chemistry. Much of the information is otherwise obtainable only in large treatises or dictionaries, and it is undoubtedly useful and convenient to have it collected in a small manual of this kind. The information is accurate and up-to-date. The book is well printed, and should prove useful to students and those engaged in laundering. The author has evidently an excellent practical knowledge of the subject.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Ether Drift Experiments.

The editor has kindly shown me the proof of a letter from Sir Oliver Lodge, relating to my ether drift experiments, and in particular to the account of this work recently given at the Royal Institution. Sir Oliver has in a very courteous manner described the principal argument put forth, and, as he says, the matter is now before the scientific world, *sub judice*. Notwithstanding this, it may not be out of order to make further explanation of some of the points raised by Sir Oliver.

It seems necessary to direct attention again to the fact that this experiment has never given a true zero or 'null' effect in general; it has only given a 'negative' result, that is, it has answered 'no' to a specific question. Following the report by Morley and Miller, in 1905, Prof. Einstein made the hypothesis that the motion of the observer produces no effect upon the apparent velocity of light. This hypothesis has been given in hundreds of books as the correct interpretation of the experiments, and has been accepted, perhaps without fully examining the original papers. Michelson and Morley, in 1887, said: "Considering the motion of the earth in its orbit only . . . the relative velocity of the earth and the ether is . . . certainly less than one-fourth of the orbital velocity. . . . In what precedes only the orbital motion of the earth is considered. If this is combined with the motion of the solar system, concerning which but little is known with certainty, the result would have to be modified." In 1905 Morley and Miller, using a much larger interferometer, included in the calculations with the orbital motion of the earth a presumed motion of the solar system of twenty kilometres per second towards the constellation Hercules (still leaving the orbital motion predominant), and came to practically the same conclusion. But, in each of these reports the effect to be expected was calculated in advance, both as to direction and magnitude, and then the observations at two different times of day (as determined from the expected result) were combined so as to add together the expected components, and so as to cancel effects other than those being looked for.

In all of these observations there was a definite positive result, which is observed as a periodic displacement of the interference fringes; but, for the two calculated times of day, the phases of the positive periods differed in such a way that when the two sets of readings were added, they neutralised each other and left only the very small result which was correctly reported as that obtained for the orbital component of any existing ether drift. It is this positive effect, then eliminated, that is now being examined. While it is not large, it is by no means insignificant; the present amount of observed relative motion is 10 kilometres per second with a probable error of ±0·5 kilometres per second. As this effect was not 'expected' it was not easy to interpret. The history of the experiment has been given in *Science* for June 19, 1925, and in a more concise report in NATURE for July 11, 1925, p. 49. The re-examination of all of the observations from 1887 to 1926, is the subject of a paper presented to the National Academy of Sciences in Washington on April 26, 1926, and not yet published. It is hoped to give a summary of this paper shortly in NATURE.

Sir Oliver Lodge asks what would appear if the results were plotted on the hypothesis that the south side of the housing is warmer than the north side, or with regard to other conditions. It is exactly for answering these questions, and others, that the experiments have been continued over a period of six years, in which time the thousands of readings have been made. Every disturbing cause that could be thought of has been exhaustively studied; among these are: daily and annual variations in temperature, meteorological conditions, radiant heat, magnetism, magneto-striction, differential gravitation, gyrostatic action, influence of method of illumination, transparent and opaque coverings of the light path, speed and direction of rotation, lack of balance in the rotating parts, position of the observer, and other conditions. One after another, these disturbances have been shown *not* to produce the observed effects. Finally, it has been possible to combine into one logical solution *all* the readings made to test all these varying conditions, without any omissions (excepting a few readings made under abnormal conditions, such as artificial heating), without any corrections, and without assigning any weights. This solution is entirely consistent with the observations of Michelson and Morley of 1887, and with those of Morley and Miller of 1902–1906.

The observations with the interferometer are made to detect a periodic shift of the fringes, periodic in each half-turn of the instrument; it is not the absolute position of the fringes that is important, but rather the periodic, vibratory change in the position of the fringes, as the interferometer turns through 180°. This can be detected best by having the instrument in slow and uniform movement, while the observer watches the fringes continuously. The instrument turns once in about a minute, and floats so freely that when once started it will continue in rotation for more than two hours without being touched. A series of readings is made in less than fifteen minutes.

The important part of the argument is that the reported effect has always been present, and is evident in every single observation and not merely in the mean; it is not related to the instrument, or to its surroundings; neither is it dependent upon day and night, or summer and winter; it is clearly shown to be directly related to sidereal time, that is, to a cosmical cause. This is explained, with numerous curves showing the results of the 1925 observations, in *Science* for May 1, 1926. The final arguments are based upon four very complete series of observations made at Mount Wilson for the epochs April 1, August 1, and September 15, 1925, and for February 8, 1926, thus covering various seasonal conditions, and various orbital positions of the earth.

In making the observations, two independent quantities are noted, the direction in which the interferometer points when the effect is a maximum; and the amount of the periodic displacement of the interference fringes. Each of these two sets of readings leads to an independent determination of the right ascension and declination of the 'apex' of the supposed motion of the earth in space. It is very significant that these two determinations are wholly concordant.

Dayton C. Miller.

Note on the Law of Radiation.

In connexion with the distribution of black-body temperature-radiation among different wave-lengths, the law of that distribution suggested by the late Lord Rayleigh for long wave-lengths is now well known to require the interesting and important correction factor $\frac{x}{e^x - 1}$ (where x is $\frac{hc}{RT\lambda}$ or, as Dr Jeans has virtually pointed out, very nearly $32\pi^3 \frac{\epsilon^2/K}{RT\lambda}$, the electronic charge being ϵ), in order to adapt it to all wave-lengths. This factor could not have been deduced from dynamical reasoning, even with the help of the electron and the laws of probability, without the postulate of a previously unsuspected discontinuity in the interaction between ether and matter Not because the expression for x (which in itself is full of speculative interest) contains any discontinuity, but because the denominator of the correction-factor ($e^x - 1$) suggests, as my brother has pointed out (Nature, May 30, 1925), a continuous accumulation at compound interest with the periodic emission of a dividend. The steady growth of a tree through a summer, with occasional spasmodic drop of an apple to a lower energy level, may be in some respects a permissible analogy.

There seems some risk that in order to emphasise the novel character of this discovery of Max Planck's, supplemented as it was by Einstein, teachers of senior physics may convey the impression that Lord Rayleigh had enunciated his law as complete; whereas he was under no such mistaken impression. He knew that his law was a partial one, and could apply only to long waves. I had thought of quoting from his original 1900 Memoir on the subject, together with a footnote added in 1902, in support of this contention (see vol. 4 of Rayleigh's "Collected Papers," p 485), since there seemed a risk of its being overlooked by readers of Dr. Jeans's admirable Report to the Physical Society on "Radiation and the Quantum Theory." But I have found that the true position is clearly admitted and stated by Dr. Jeans in his book on "The Dynamical Theory of Gases" (p 359, third edition).

Rayleigh's law, I may remind readers, is that if E is the total radiated energy at the temperature T (which energy may be plotted as an area with a wave-length base) its distribution among different wave-lengths (or the ordinates of the continuous-spectrum energy curve) will be:

$$dE/d\lambda = 8\pi RT\lambda^{-4}.$$

Rayleigh threw out his suggestion as the simplest definite form of Wien's thermodynamically-derived and well-established so-called "displacement law" connecting energy at each wave-length with absolute temperature:

$$\lambda^{-5}\phi(\lambda T).$$

The new form represented a special case; and the replacement of λ^{-5} by $\lambda^{-4}T$ was convenient for several reasons: (1) Because it emphasised the fact that atomic energy in each mode must be proportional to T (which was disguised in Wien's form); (2) because it brought in the known gas constant instead of an unknown function; and (3) because it was in accordance with the Maxwell-Boltzmann law of equipartition.

Rayleigh expected that his expression might represent the true law of radiation when λT was great; and so it has turned out. The law is true so far as *matter* is concerned; that is, it is true if an atom radiated, as a sounding body does, into a material medium. That something more was required to bring in non-matter, like the ether, was clear, because for some unknown reason equipartition would not apply to that; even proportionality to temperature need not hold in the ether. No one could deduce the complete law without further discovery. Each step from matter to ether, or back again, demanded the quantum factor, and does demand it wherever such interaction occurs. The gradual Keplerian manner in which the true law was guessed was a triumph of genius. Bohr's subsequent pictorial representation of the quantum at work, in the structure and behaviour of a radiating atom, was another. In this connexion I find that an ancient address of Clerk Maxwell's to the Chemical Society in 1875 (which I had the privilege of hearing, and which is reported in Nature, vol. 11, pp. 357, 374) contains the following now rather amusing anticipatory paragraph (see also p. 435, vol. 2, of Maxwell's "Collected Papers"):

"The theory of the possible vibrations of a molecule has not yet been studied as it ought, with the help of a continual comparison between the dynamical theory and the evidence of the spectroscope. An intelligent student, armed with the calculus and the spectroscope, can hardly fail to discover some important fact about the internal constitution of a molecule."

We are living in a period of remarkable discoveries, which rather tend to put in the shade some of the older physics. Nevertheless, as an intermediate stage, complete so far as matter is concerned, Lord Rayleigh's partial statement was most useful. It never pretended to be more complete than it was, and it is only fair to his well-known care and scrupulous caution to emphasise this. Oliver J. Lodge.

Normanton House,
Lake, Salisbury.

Plastic Deformation of Single Metallic Crystals.

In a letter to Nature (May 22, p 720), Messrs. Millington and Thompson discussed the wedge-shaped fracture which ordinarily results from a tensile test on a single metallic crystal. On the assumption of uniform slip on a number of parallel planes they calculate the magnitude of an angle which they assume to be the angle of a wedge-shaped fracture produced by the slip. May I point out that uniform slip of the type they consider, on one or more sets of parallel planes, would result in uniform extension together with a uniform change in the cross-section over the whole of the portion of the specimen which is slipping, and consequently no wedge-shaped fracture could result? The angle which was calculated in the letter referred to is the inclination of the axis of the 'slipped' portion of the specimen to the axis of the portion which has not slipped, and this has no connexion whatever with the angle of a wedge fracture.

In the earlier stages of a tensile test on a single crystal the act of slipping on any plane increases the resistance of that plane to further slip. This has the effect of distributing the slip more or less evenly over all the planes of the same type so that uniform extension results. At some stage, however, this strengthening action appears to become exhausted and a zone of weakness is set up. The final wedge fracture results from non-uniform slip in this region, the extent of the slip on the set or sets of planes involved becoming progressively greater as the weakest point is approached from either side. No calculation of the angle of the final fracture can be made without some information as to the nature and extent of the zone of weakness referred to, and there appears to be no evidence available on this point. However, it may, I think, be definitely stated that the occurrence of a wedge-shaped fracture is an indication that non-uniform slip has occurred in its neighbourhood. The only deduction that can safely be made from the shape and orientation of the wedge concerns the number of sets of parallel planes involved. In general slip occurs on two such sets, and the final line of cleavage will be parallel to their lines of intersection. The actual examination of a number of fractures of single crystals of aluminium encountered by the writer and his colleagues in the course of an experimental research into their behaviour under stress, shows that in every case the faces of the wedge are not plane but are definitely curved surfaces.

I would strongly suggest that general deductions as to the distribution and amount of slip, from geometrical considerations or from the representation of atoms by hard spheres, unless supported by carefully obtained experimental evidence, should be treated with great caution. S. J. WRIGHT.

Engineering Department,
National Physical Laboratory,
Teddington, Middlesex,
May 29.

Dipole Moment and Molecular Structure.

DEBYE (Marx, "Handbuch der Radiologie, 6, 597) has shown how the electrical moment or dipole moment of a molecule can be determined from dielectric constants and refractive indices of vapours and dilute solutions. Debye and other workers find that the dipole moment for a series of homologous compounds is nearly constant. The dipole moment, therefore, may be associated with a definite polar group in the molecule, whilst the rest of the molecule is non-polar. The dipole moment is a vector quantity. Hence the dipole moment of a molecule, which contains several polar groups, should be the vector-sum of the dipole moments of the groups; compare Errera, *J. Phys. Radium, VI.*, 6, 390 (1925).

To test the above theory the present experimental investigation has been carried out. The results are collected in the following table. The experimental dipole moment μ is calculated for infinite dilution in benzene solution. Simultaneously the association constant k may also be determined. The theoretical dipole moment v is calculated as the vector-sum of the moments of the monosubstituted derivatives, assuming the angles between the ortho, meta and para directions to be 60°, 120° and 180° respectively. The following dipole moments have been taken from earlier publications, namely, $\mu = 3·75 \times 10^{-18}$ E.S.U. for nitrobenzene, and $\mu = 0·43 \times 10^{-18}$ for toluene.

	μ.	v.	k.
Chlorobenzene . .	$1·58 \times 10^{-18}$	..	0·04
Bromobenzene . .	1·56	..	0·10
Dimethylaniline .	1·39	..	
o-Dinitrobenzene .	5·95	$6·5 \times 10^{-18}$	0·36
m-Dinitrobenzene .	4·02	3·75	0·26
p-Dinitrobenzene .	0·8	0·00	
sym Tribromobenzene	0·3	0·00	
O-Nitrotoluene . .	3·56	3·62	
p-Nitrotoluene . .	4·30	4·18	0·24
o-Chloronitrobenzene	4·25	4·75	
m-Chloronitrobenzene	3·38	3·27	
p-Chloronitrobenzene	2·52	2·17	0·07
p-Bromonitrobenzene	2·69	2·19	

The small dipole moments are not exact, because of the so-called atom-polarisation: L. Ebert (*Z. Phys. Chem.*, 113, 1 (1925)). The polarity of groups must be due to charges on the atoms in the groups. If it is assumed that one charge is on the group and the opposite on the benzene ring, it is found, from the relative directions of the component moments, that chlorine, bromine and the nitro-group are charged in the same manner, whilst the methyl group is oppositely charged. The work is being continued.

The present work was carried out in the Chemical Laboratory of the University of Copenhagen. The author wishes to express his thanks to Prof. Billmann and to the Orsted foundation of the Great Northern Telegraph Co., Ltd., for a grant.

KRISTIAN HÖJENDAHL.

Efficient Use of Thermopiles.

IT is well known that when using a very delicate thermocouple or a thermopile for the measurement of weak intensity radiation, it is of advantage to work the pile *in vacuo*. The effect obtained is threefold: (*a*) Increased sensitivity; (*b*) Improved constancy of the galvanometer deflexions; (*c*) Increased steadiness of the galvanometer.

The value of the first is small, the factor being about three times, unless special care be taken to reduce to a minimum the conduction of heat along the wires of the thermo-elements. (Cf. Moll and Burger, *Z. für P.*, 32, 575, 1925; also *Phil. Mag.*, 50, 624, 1925.)

(*b*) In the absence of a vacuum, and when the total radiation falling upon the pile is great enough to cause an appreciable difference of temperature between the two sets of junctions, minute convection currents are set up in the air, with consequent fluctuation in the magnitude of the galvanometer deflexion. This trouble is not noticeable if the deflexions are small.

(*c*) This is of very real value. The major portion of the disturbance experienced in working with a thermopile in air is due to the unequal heating and cooling of the two junctions of each thermo-element, by the minute and continual adiabatic variations of pressure of the atmosphere. These disturbances become relatively very large as the sensitivity of the galvanometer used for the measurement of the thermo-electric current is increased. It may not always be convenient to work with a vacuum pile, but to secure the benefits conferred by (*c*) it is only necessary to enclose the pile in an air-tight casing, an experimental problem very much easier of solution than the construction of a casing to hold a high vacuum indefinitely. Apparently this simplification of the problem is not generally realised, and I can from my experience here vouch for the efficacy of the method.

In this connexion, it may also be of interest to note that when working with a galvanometer of the Paschen type, of a figure of merit of about 19,000, also when using a Boys' radiomicrometer, it was found possible to eliminate mechanical disturbances only when the instruments were stood directly upon a concrete pillar let into the foundations of the building. Earth tremors, etc., might then produce a temporary minute disturbance, which died rapidly away, leaving the zero unchanged; whereas if any system of suspension or mounting upon rubber in any form were used, chance earth tremors maintained the suspended system in a continual state of minute vibration.

A. MAURICE TAYLOR.

Laboratory of Physical Chemistry,
University of Cambridge,
June 5.

The Evolution of Beauty.

DARWIN sought for an explanation of the ornaments of animals, their bright colours, beautiful songs, and all their structures and habits that could not be explained as the result of natural selection, and he found a perfect one in the instincts possessed by the unornamented sex, usually the females, of choosing as mates the more beautiful of their suitors. But this theory, although it explains the ornaments by the instincts, makes no reference to the evolution of the instincts.

It seems plain that a female which gives her descendants dangerous habits and structures will soon have no descendants, yet some of the practices and structures of the males are dangerous, and the female instinct to choose these has evolved, apparently in defiance of natural selection.

The better mate an animal can get the more chance its descendants will have of survival, and it is obvious that a male that has to face more danger and yet manages to survive has in all probability a greater capacity for keeping alive than one which lives through less danger. Therefore the female that chooses a mate with a dangerous habit or structure chooses what is, apart from the dangerous part, a better and more fit mate.

No species can rise directly above its environment, for if there is less killing there is less selection, and variations for the worse soon drag the whole species down into the arena, even if it does contrive to climb out. The only way in which selection can be escaped is for some individuals to be handicapped and sacrificed, taking the selection upon themselves, so that their descendants, or at all events some of them, may escape it.

This is exactly what has happened. The female has forced the male to seek danger and endure rigorous selection in order to win her, and, while his handicap has descended only to the male line, the vitality which was his that he might bear it has descended to both sexes equally.

The whole advantage is on the female side, consequently anything which tends to make the female more valuable than the male favours the development of sexual selection. Compared with the females the males of polygamous animals are valueless, and it is noteworthy that among the higher animals all, or almost all, the polygamists indulge in sexual selection.

C. H. HENSHAW.

11 Belmont Street,
London, N.W.1, May 31.

The Line Spectra of Isotopes.

COMPARISONS of the spectra of the isotopes of lead have shown that they are indentical, except for slight wave-length differences of the order of a few thousandths of an Ångström unit. Our inability completely to separate the isotopes of other non-radio-active elements in quantities for spectroscopic investigation has left this the only experimental result of a direct nature. In order to find possible evidences of the effect in two other elements, the writer has made an accurate comparison of the spectra of samples of mercury having different atomic weights, and also of similar samples of chlorine. These have been produced by long-continued fractional diffusions in the laboratory of Prof. W. D. Harkins, who kindly made them available for this investigation.

The best mercury used had an atomic weight difference of 0·18 units. A calculation showed that the proportions of isotopes 198 and 204 in these samples differed by about 20 and 27 per cent, respectively, of their values for ordinary mercury. The lines were compared, using an echelon of R.P. 400,000 and a plane grating the R.P. of which in the fifth order was 478,000. No differences in the wave-lengths of the lines λλ5461, 4359, 4078, and 4047, or any of their satellites, were found which were greater than the error of measurement (3×10^{-4} Å.U.) The relative intensities of the satellites of a line were always visually identical in the two spectra. This observation has a direct bearing on some recent discussions which have appeared in the columns of NATURE, particularly those of Nagaoka and his associates, according to whose ideas we should expect intensity differences of 1/4 and 1/5 in the satellites corresponding to isotopes 198 and 204.

The chlorine lines from two specimens differing by 0·097 atomic weight units, when examined with the echelon, showed distinct evidence of shifts in some cases. Wherever these were observed, the heavier chlorine appeared to give the shorter wave-length. The shifts were small, however (0·0012 Å.U in the largest of the trustworthy cases, λ4741), and their exact values cannot be given, since they were at most only two or three times the experimental error.

The experiments were carried out in the Physics and Chemistry Departments of the University of Chicago, and the writer is indebted to Prof. H. B. Lemon for many valuable suggestions. A fuller report of these results will be given elsewhere.

FRANCIS A. JENKINS.
(National Research Fellow.)

Jefferson Physical Laboratory,
Harvard University, Cambridge, Mass.

The Isotopes of Sulphur.

SULPHUR is one of the elements used in the fundamental calculation of atomic weights, and there is no reason to doubt the substantial accuracy of the fractional value 32·06 ascribed to it. The results of its analysis by the mass-spectrograph (NATURE, July 1, 1920, p. 547) were indecisive, owing to the fact that the resolving power of the instrument, about 1 in 130, was insufficient to separate the line due to molecular oxygen from that of a sulphur atom of the weight above, if the latter existed. There were many other lines on the plates, which might have been due to isotopes present in small percentages. Those at 33 and 34 were particularly noted (*Phil. Mag.* 40, 632, 1920), but with the knowledge then available it seemed safer to ascribe these to hydrides and to rest content with the certain conclusion that atoms of mass number 32 were present in preponderating amount.

I have now been able to raise the resolving power of my new instrument to about five times that of the old one, sufficient to show the lines of O and CH_4 clearly separated by more than half a millimetre. Subject to this analysis the line 32, obtained under conditions such that O_2 and S must both have been present, showed no sign of doubling. This proved that isotopes of higher mass-number must exist. Further study with gases containing SO_2 indicated that the suspected faint companions at 33, 34 (S); 49, 50 (SO); 65, 66 (SO_2), were present on all spectra, even when the conditions were such as to make the presence of hydrides very unlikely. They also showed intensity relations consistent with true isotopic character.

The matter has now been put beyond reasonable doubt by the negative mass-spectrum obtained by using pure SO_2 and exposing for an hour with both fields reversed. All three lines were visible, and again showed the same intensity relations. Sulphur is therefore a triple element like the two even ones, magnesium and silicon, which precede it in the periodic table. The lightest mass-number is far the most abundant in all three cases. S^{34} appears to be about three times as abundant as S^{33}; the two together probably amount to about 3 per cent of the whole.

The band spectra of suitable sulphur compounds should well repay a careful study, since they should exhibit an isotope effect similar to that so beautifully demonstrated by Mulliken in the case of silicon.

F. W. ASTON.

Cambridge, June 12.

Numerical Reduction of Instars in the Metamorphosis of Euphausids.

THE development of an animal from the zygote up to the adult condition is usually accompanied by a more or less regular and continuous increase in size. In the case of the Arthropoda, however, the enclosure of the body in a hard inextensible layer of chitin renders this impossible, and in accordance with this the chitinous exoskeleton is shed from time to time, each moult or ecdysis being followed by a rapid spurt of growth until the process is again blocked by the hardening of the new chitinous layer. In many of the better-known arthropods particular moults are associated with the attainment of particular stages of development—*e.g* the penultimate and the last moult of a Lepidopterous insect—and the idea is very generally held that this applies to *all* ecdyses or moults in the Arthropoda. Consequently, when in the study of plankton it is found that specimens of the young of some particular crustacean fall into a large number of different types demarcated by slight differences in size and form, one very naturally regards these as forming typical successive stages of the life-history, the whole series being worked through by each developing individual.

The object of this communication is to record that recent work at the Millport Marine Station upon the Euphausidæ would appear to invalidate the belief indicated above. From observations upon *Meganyctiphanes norvegica*, it seems clear that the individual does not necessarily go through the thirty or so moults which have been assumed to demarcate definite successive larval stages. On the contrary, the suspicion is forced upon one that the act of ecdysis does not by any means form a fixed landmark in the developmental history of the individuals. Should this suspicion turn out to be correct it will obviously involve important modification of our current conceptions of arthropod development.

R MACDONALD.

Marine Biological Station,
Millport, May 19.

Abraham de Moivre.

TRAVELLING in countries where NATURE was not available in public libraries, it was not until to-day that I was able to consult the issue of April 17, in which my letter, with Prof. Pearson's comments, appears I must decline to accept responsibility for the statement attributed to me by Prof. Pearson, namely, that I spoke "as if the matter in the 1738 'Doctrine of Chances' and again in the 1756 edition was a mere translation 'except for minor changes'" What I *did* write was that a translation of the pamphlet under discussion appeared, except for minor changes, in both editions. I still believe this statement to be absolutely accurate. It is, of course, true that after this translation there are in the 1756 edition of the "Doctrine" 'Remarks,' and other material. Prof. Pearson regards the Remarks as of great historical importance. I am glad that in this connexion my letter drew forth his further comments on the history of statistics

May I add that my letter was written with a photographic copy of the pamphlet before me, as my reference to the *Isis* article indeed suggested Typographic considerations, which Prof. Pearson suggests, would scarcely lead me to his conclusion. But in the light of Moivre's positive statement that the contents of the pamphlet were first "made public" in 1738, it does not appear to me possible to consider the earlier pamphlet, "communicated to some Friends," as a second supplement to the "Miscellanea" of 1730.

I closed my last letter with the sentence, "It would be interesting to learn if any other copy of Moivre's original pamphlet is in existence." I have here found another copy in the Preussische Staatsbibliothek, bound in with the "Miscellanea" Are there other copies ?

R. C. ARCHIBALD.

Berlin, June 2.

The Taxation of Research.

IN "News and Views" of NATURE of June 19, p. 866, it is stated that there is a "semblance of overstatement" in our letter on the above subject published in the same issue. In justice to the Chemical Society we think this remark "requires some slight modification"

The published balance sheet of 1925 is quoted as illustrating the financial position of the Society, but had the balance sheets for previous years been examined as well, it would have been found that the *actual* deficits on the years' workings were as follows: 1920, 2853*l*.; 1921, 1104*l*.; 1922, 584*l*.; 1923, 1628*l*.—a total of 6169*l*. in four successive years, despite the raising of the subscription from 2*l*. to 3*l* in 1921. It was only by drastically cutting down published papers—even to the point of unintelligibility—that we were able to obtain a credit balance of 210*l*. in 1924 and another of 466*l*. in 1925, the latter including, however, a grant of 350*l*. from the Government Publications Grant

It is clear that in these circumstances "solvency and bankruptcy" are closely related to "surplus and deficit" on the year's working, and that even the substantial sum given as invested capital cannot long withstand depletion at the rate illustrated above.

H. B. BAKER, President.
JOCELYN THORPE, Treasurer.

Royal College of Science, South Kensington,
London, S.W 7, June 21.

Frictional Forces in Liquid Surfaces.

MR. CHASE in NATURE of May 22, p. 724, deals with a phenomenon which probably many have noticed. The effect produced is, I think, due entirely to the surface tension of the liquid acting on the wire where it breaks the surface.

Unless the liquid surface be of large extent a resultant force is in general set up on the wire in the plane of the surface, and if the axis of rotation of the moving system does not meet the surface in the same point as the wire, free rotation is impeded.

This form of apparatus gives a great deal of trouble in use, for the forces set up may be comparatively large. It is of course theoretically possible to find the neutral point in the surface and to adjust the axis of rotation and the suspended wire so that they both pass through it, but these adjustments are difficult to maintain, and observations made with the apparatus are liable to a very uncertain source of error.

L. H. G. DINES.

73 Fairfax Road, Teddington, June 6.

The Light-Quantum Theory.[1]

By Dr. C. D. ELLIS.

IT is well known that the wave-theory of light fails to explain certain phenomena, and so much has been written on this subject already, that it seems at first sight unnecessary to emphasise this point. But although the main problem has not altered and no solution has been found, yet the general attitude towards this question is slowly changing, and several important new experiments have been carried out. Recently a new theory was put forward by Bohr, Kramers and Slater which would have removed many of the difficulties, but experiments by Geiger and Bothe quickly showed it to be incorrect. This theory and its refutation were not without their effect, and now the attitude is frequently held that the light-quantum theory is not merely a crude picture of certain facts, but is an important theory no further from the truth than the wave-theory. The wave-theory itself cannot be correct, but except for its greater age it has no greater claims than the light-quantum view.

These two theories give entirely different pictures of the nature of light, as is expressed by their names. The wave-theory pictures the radiant energy as spreading out in all directions from the source, filling every portion of the surrounding space, so that the propagation may be imagined to be a handing on of the energy from point to point. It is an essential feature that except in special cases the intensity of the forces in the light wave diminish rapidly with increasing distance. Any theory will predict that the average energy density will diminish with the inverse square of the distance, but the law of variation of the forces is peculiar to each theory. The triumphs of the wave-theory scarcely need emphasis. By its means all the intricacies of interference and diffraction problems can be explained in the smallest detail, and in every problem involving direction this theory is in complete agreement with experiment.

It is only when we consider the interchange of energy between radiation and single atoms that the wave-theory breaks down, and the completeness of this breakdown is best seen by considering the photoelectric effect. To take a definite case, suppose X-rays are incident on a plate of some material, then it is found that electrons are ejected from the plate with considerable velocities. The number of electrons depends on the intensity of the X-rays and diminishes in the usual way as the plate is moved farther from the source of X-rays. The velocity or energy of each electron, however, does not vary but depends only on the frequency of the X-rays. The electrons are found to have the same energy whether the material from which they come is close to the X-ray bulb or whether it is removed away to any distance.

This is a result which is quite incompatible with the ordinary wave-theory of radiation, because as the distance from the source increases the radiation spreading out on all sides becomes weaker and weaker, the electric forces in the wave-front diminishing as the inverse square of the distance. The experimental result that the photoelectron always picks up the same amount of energy from the radiation could only be accounted for by giving it the power either to collect energy from a large volume or to collect energy for a long time. Both of these assumptions are unworkable, and the only conclusion is that the radiated energy must be localised in small bundles.

This is the basis of the light-quantum theory. Light of frequency ν is considered to consist of small bundles or quanta of energy all identical and of magnitude $h\nu$, h being Planck's constant. These quanta travel through space, being unaffected by each other, and preserving their own individuality until they make a suitable collision with an atom. Then if the quantum is absorbed the whole energy is transferred to the atom and an electron will be ejected. It can be seen that this hypothesis is so designed that the velocity of the photoelectrons is accounted for, first in the dependence on frequency, since the energy given up is always just one quantum, which bears the correct proportionality to the frequency; and secondly in its independence on the distance from the source, since although when the source is distant fewer quanta will arrive, those that do arrive will still give up the same invariable amount of energy to the atom.

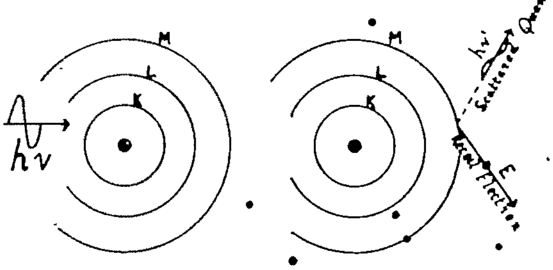

FIG. 1.—Diagrammatic representation of the mechanism of the scattering of X-rays in accordance with the relation $E + h\nu' = h\nu$.

This theory is also capable without further modification of accounting for the Compton effect. Compton found that X-rays suffered a change of wave-length when they were scattered. Now, scattering on the light-quantum hypothesis means a deflexion of the quantum, and since this quantum with its energy $h\nu$ will have momentum $h\nu/c$ where c is the velocity of light, this means further that the electron which deflects it will receive an impulsive blow. Fig. 1, in which the orbital electrons of the atom are represented by concentric rings, illustrates such a process. The left-hand picture is supposed to represent the quantum just about to collide with an electron in the M ring. The right-hand picture indicates how the quantum is deflected and sends off sideways the electron with which it collides. If, as the hypothesis demands, we consider energy to be conserved, then the energy of the scattered quantum plus the energy of the recoil electron must equal the energy of the initial quantum. In other words, the scattered quantum must have a smaller energy, which means lower frequency (since energy $=h\nu$) or longer wave-length. The theory at once suggests the simple qualitative result of Compton's experiments, and it is a striking point that the consideration of the simple dynamics of the collision lead directly to a complete quantitative agreement also.

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[1] Substance of three lectures on "The Atom of Light and the Atom of Electricity," delivered at the Royal Institution on February 25 and March 4 and 11.

It can be seen that the light-quantum theory explains two important phenomena, but in this crude form it fails to give any explanation of diffraction and interference just as completely as the wave-theory fails to explain the photoelectric effect. These two theories are clearly incompatible, and many attempts have been made so to modify either one or the other that it might explain the rival phenomenon. We find modifications of the wave-theory which attempt, on the whole unsuccessfully, to account for photoelectric phenomena; and again, there is another class of theories which make arbitrary rules to direct the light-quanta along such paths as would be necessary to give the correct interference patterns.

The most serious theory of the first class has been proposed by Bohr, Kramers and Slater, and it must be held greatly to the credit of this theory that it was sufficiently precise in its statements to be disproved definitely by experiment. The Bohr theory took its origin from the observation that it was only in the prediction and explanation of the energy relations that the wave-theory failed, and this failure could be briefly stated by saying that on the wave-theory there is never enough energy at the right place to produce the observed changes. These authors therefore suggested that energy might not necessarily be conserved in each interchange of energy between an atom and radiation, but only when a very large number of such interchanges were considered. For example, an atom which was in a radiation stream of frequency ν could suddenly acquire energy $h\nu$ by means of the action of the radiation, although the energy density of the radiation might be so small that this amount of energy could only be found in a volume a million times greater than that of the atom and there would be no possibility of imagining any kind of collecting process. However, if a very large number of such processes were considered, then the total amount of energy abstracted from the radiation would be equal to the energy absorbed by the atoms.

The merit of this theory was that it rendered possible the calculation of the probabilities of such processes in a manner analogous to the calculations of absorption and emission on the pure wave-theory. It promised such a complete solution of the difficulty that immediately experiments were started to test its accuracy. One such experiment was carried out by Geiger and Bothe on the phenomenon of the Compton scattering, which has been referred to above. The essential features are that when X-rays are scattered the scattered radiation shows an increased wave-length and low velocity electrons are liberated from the scattering atoms. The energy relations in this process are those that would be expected if a light-quantum endowed with mass and momentum were to collide with an electron and be deflected. As a result of the collision the electron will be driven sideways, forming one of the recoiling electrons. It is clear how the light-quantum theory predicts definitely that to every scattered quantum there must occur at the same moment a recoiling electron. On Bohr's theory these two events would not occur at the same moment, there would be no detailed connexion between any one recoiling electron and any particular portion of the scattered radiation. All that is required is that, on the average, energy should be conserved. From this it may be seen that a decision between the two theories will be reached if it is possible to settle whether to each recoiling electron there corresponds a scattered quantum, or whether the scattered radiation is radiated continuously.

Geiger and Bothe directed a stream of X-rays on to a small volume of hydrogen, and on either side of this were arranged two counters. These consisted of small chambers charged to a high potential with an inner insulated electrode. When a single electron traverses the gas in such a counter there is a sudden flow of electricity to the electrode, which may be registered by a suitable instrument. One counter was open to receive the recoiling electrons, the other was to register the radiation, and was closed by a thin metal foil. On the light-quantum view we should say that the quanta incident on the foil will sometimes eject an electron into the counter, which will then register it. Since every recoiling electron must be accompanied by a scattered light-quantum there should be a detectable number of coincidences between the indications of the two counters. On Bohr's theory the scattered radiation comes off in a continuous stream, and passing through the metal foil on the face of the counter, will from time to time liberate electrons. Although on this theory there should be just as many electrons liberated as on the previous theory, the important point is that now the secondary electrons will have no direct connexion with the recoiling electrons, and there would be no reason to expect coincidences between the indications of the two instruments.

The result of this experiment was decisive; undoubted coincidences were found to occur between the indications of the electron counter and the radiation counter. This could not be accounted for on Bohr's theory, which consequently had to be abandoned. But at the same time it provided additional support for the light-quantum view, although it certainly is not a proof of its correctness.

Bothe has recently carried out a further experiment on similar lines which is specially interesting, since in this case Bohr's theory would predict coincidences whereas the light-quantum theory would not. A small piece of iron foil was placed between two 'radiation' counters and radiated with X-rays so that it emitted its own characteristic radiation. If this radiation consisted of localised quanta, then it is clear that any one quantum could go into either one counter or the other, but it could not possibly be absorbed in both counters at the same time, and there should be no coincidences between the indications of the two counters. On the other hand, if the characteristic radiation from the foil spreads out in a spherical wave, this wave will pass through both counters at the same time, and occasionally will stimulate an absorption act in both counters simultaneously, so that on this theory coincidences should be found. Experiment again decides definitely against the theory of Bohr, Kramers, and Slater, and gives the result that would be expected on the light-quantum view. This is the fate of the most serious theory which has attempted to solve the fundamental difficulty by preserving the wave-theory but altering our pictures of the absorption and emission of energy by atoms.

There is another group of theories which postulate that radiation consists of discrete quanta. Thus they explain automatically the photoelectric effect and the Compton scattering, and then attempt to account for diffraction and interference by laying down rules which shall determine the paths these quanta shall follow. The light-quantum theory accounts for all the effects once the quanta are got to the right place, but in its crude form it gives no suggestion of the quanta moving in anything but straight lines, and it is only the wave-theory which predicts successfully the directions in which light travels. Hence theories have been proposed which provide 'tramlines' along which the quanta move, and these 'tramlines' are so arranged that in a system of interference bands 'tramlines' only lead to the bright bands and none to the places of zero intensity. To be more precise, the 'tramlines' are supposed to be the paths of the Poynting vector of a virtual radiation field emitted by the atoms, and the probability of a quantum travelling along a given path is connected with the value of the Poynting vector along that path. Such theories meet with many difficulties, and no one has yet been carried to the point where it can be tested by experiment.

This has been discussed in detail recently by Prof. G. N. Lewis in an article in NATURE (February 13, p. 236), in which he also puts forward an original view on the whole problem. It is a striking fact that while all the theories are directed towards explaining the propagation of light, one theory suggesting that it occurs in the form of waves, the other in the form of corpuscles, yet light has never been observed in empty space. It is quite impossible to observe light in the course of propagation; the only events that can ever be detected are the emission and absorption of light. Until there is some atom to absorb the radiation we must be unaware of its existence. In other words, the difficulty of explaining the propagation of light may be because we are endeavouring to explain something about which we have no experimental evidence. It might be more correct to interpret the experimental facts quite directly and to say that one atom can transfer energy to another atom although they may be far apart, in a manner analogous to the transference of energy between two atoms which collide. Prof. Lewis says: "I shall make the contrary assumption that an atom never emits light except to another atom, and that in this process, which may rather be called a transmission than an emission, the atom which loses energy and the atom which gains energy play co-ordinate and symmetrical parts."

On this view the fringes in an interference system are to be regarded as forming one system with the source in the sense that the atoms which absorb the light at the bright fringes are in 'virtual' contact with the atoms in the source, whereas those in the dark fringes or any place where the light does not go are not in virtual contact. On this view there would never be any discussion as to where radiation goes, but only as to which pair of atoms could make up an emitting and absorbing couple.

The foregoing shows clearly that there is at present nothing approaching a complete theory of light, but yet it must be remembered that it is an important practical achievement that a complete description can be given by means of two theories, providing the appropriate theory is used for each phenomenon. Both these theories have more than justified the care and trouble spent on their elaboration by the help they have given to experimental work, and also on the theoretical side they represent an important advance in our knowledge of light. It would not be right to deduce that both theories are necessarily incorrect; it might be closer to the truth if we were to compare them to the plan and elevation of an engineering drawing. The wave-theory and the quantum-theory may be just the plan and elevation of the true theory of light, and the marked contradictions between them may be due to the language we use to describe the experimental results, just as the differences between a plan and elevation reflect our attempt to describe in two dimensions a three-dimensional object.

The Origin of Petroleum.

By HENRY B. MILNER.

EVERY branch of natural science possesses its quota of time-honoured problems awaiting solution; these serve to maintain an essential stimulus to contemporary thought and to animate that discussion from which progress alone is possible. Controversy, however, unless confined within legitimate bounds of clear issues, is prone to irrelevancies and digressions to an extent that, proverbially, the 'forest' of significant observations tends to be blurred by the 'trees' of individual conjecture and detail: thus is truth obscured and explanation postponed. So it is with the science of petroleum; the problem of its genesis remains paramount, partly because there are more hypotheses than even plausible solutions based on fact, mainly for the reason that the real perspective of the problem is being lost in the maze of accumulated detail and argument. It was not only appropriate but essential that, to avoid further confusion, some one should see round rather than into the problem of mineral oil origin, that the ground should be cleared by correlation of definite data of constructive theories, thus propounding a unified hypothesis from which future research could trend with some hope of positive results. It is from this viewpoint that Mr. Ernest Clark has surveyed his subject, and his thesis (presented to the Institution of Petroleum Technologists on May 25) more than justifies his entry into this difficult field of debate, chiefly by his careful analysis of the situation, by his elimination of the unessential, and by his attempt (entirely successful) to point the way.

At the outset the author tacitly discards all theories of inorganic origin of petroleum, so that we are saved the boredom of recapitulation of text-book paragraphs. He takes his stand on organic theories, and in this the majority is undoubtedly with him. We have to realise that oil formation is as much a definite and normal phase of sedimentation as that of coal, and that no curious mechanism or exceptional process has to be invoked to explain its existence. Thus, just as in studying coal our attention is directed mainly to its mother-substance and the biochemical changes whereby that substance has been made to assume its present form, so with petroleum the problem of genesis is essentially one of the nature and deposition of mother-substance and the subsequent chemical and biological reactions involved in its metamorphosis.

Those classes of organisms which, by their nature and abundance, are potentially favourable as constituents of the mother-substance of oil, belong both to the animal and vegetable kingdoms; of the latter, algæ, diatomacea, and bacteria comprise the planktonic forms, though benthonic forms contribute, such as the seaweeds; water ferns (rhizocarps), terrestrial, fresh-water, and salt marsh grasses may be similarly contributive. Of the animals, foraminifera, corals, mollusca, and fish are mainly concerned in the supply of requisite materials; planktonic, vagrant benthonic, and normal benthonic foraminifera are alike prolific and significant; corals are sedentary benthonic forms of warm marine habitat, possibly of less importance; molluscs favour a shallow water, often a muddy environment, and are accordingly suggestive, while fish, being both marine and fresh-water nekton, are abundant in shallow seas and continental shelves, significant also in their pursuit of essential planktonic food. Thus we perceive the existence of proteins, fats, and carbohydrates in varying proportions in the mother-substance of oil, carbohydrates (cellulose, etc.) characteristic of plant contribution, proteins and fats of animal ingredients. Restriction of any one form, either animal or vegetable, is, as the author shows, dependent on environment, though from a chemical viewpoint fats, either of foraminiferal or algal origin, are conceivably the most important sources of mother-substance.

Decomposition of such organic matter implies mainly oxidising reactions; the rate of oxidation varies necessarily with the available supply of oxygen in the aqueous environment, and here we perceive a selective factor capable of segregating matter of similar chemical composition from a chemically heterogeneous organic mass; some foundation of uniformity in certain important constituents of petroleum may possibly be traceable to this. Again, abundance of marine life depends largely on adequate supply of planktonic food as well as on sufficiency of oxygen; thus conditions creative of or sympathetic to high organic mortality (hence plentiful supply of mother-substance), tend to favour rapidity of oxidation of the organic matter. “The association of prolific micro-organic remains with strata which are believed to have produced petroleum is of very frequent occurrence, and due significance should be attached to this fact.”

In the matter of organic deposition, gulf and inland sea conditions seem to be most favourable, evidenced by a study of many Tertiary oil-fields. These environments often imply rapid and fluctuating sedimentation, sometimes with restricted oxidising influences. Though in this connexion the author did not consider the circumstances of palæozoic deposition, instanced by the great oil-fields of North America, these occurrences do not imply manifestly dissimilar environments, if visualised on a sufficiently large scale; the nature and process of organic contribution are certainly parallel.

The association of petroleum with brine is almost universal, and this ‘indication’ has to be stressed. The theory that such brines represent partially altered connate waters would seem to be nearest the truth, especially when it is remembered that compaction of the salt-water saturated sediment and implied orogenic movement would cause circulation of such connate fluid, afterwards diluted by meteoric fresh-water infiltration, a factor to the migration or removal of oil and gas.

The data of chemical change of organic matter to petroleum are yet obscure, despite the mass of experiment. Putrefaction by bacterial influence is at least a reasonable starting-point; thereafter the reactions would seem to be largely micro-biochemical. A simple pressure-heat distillation as a process is untenable, at least as a general mechanism, in view of observed facts, such as the absence of a common vertical gradation of oils in the field. The necessary reactions might be expected to take place at low temperatures, not above 150° C., possibly much lower; but throughout, some kind of bacterial control would seem to be strongly indicated, quite apart from the influence of extraneous geological circumstances, such as type of sedimentation, presence and potency of colloidal matter, and so on.

Ultimate composition of a crude petroleum thus becomes a function of the initial nature of the mother-substance, its environment and mode of deposition, and the chemical reactions which transform this material into petroleum hydrocarbons, also to some extent of the changes occasioned by the contact of the oil with different rock-types and with subterranean waters. From this point of view the author defines the essential directions of future research; these involve careful investigation of sediments forming at the present time, detailed knowledge of lithology and palæogeography of petroliferous sediments, also of the controlling factors to the movements of oil, gas, and brine in such sediments; from these results it is contended that chemical problems would probably be outlined. It would seem to be unnecessary, however, to await the result of geological investigations before defining or studying the chemical problems, since these, at least, are equally formidable. Clearly the work is that of biochemists and bacteriologists, quite apart from the other specialists envisaged, and the sooner such co-operation is brought about, the sooner will emerge critical data. We have more than once stressed the value of such collaboration with geologists engaged on these ‘border-line’ problems; while the author's work marks a step forward in disposing of irrelevant theory and useless detail, and in focussing attention on the essential organic origin of petroleum, it does equal if not greater service in clearing the ground for a corporate effort from which a true solution to this fascinating problem alone can spring.

Obituary.

Sir William B. Leishman, K.C.M.G., C.B., F.R.S.

The death of Sir William Leishman after a brief illness is one that will be widely and keenly felt in many circles, scientific and military, and not least by the corps to which he had given a lifelong devotion and to whose headship he had attained by sheer merit and force of personality three years before his death. His decease also breaks the circle of Service officers whose labours have opened up new ground in tropical medicine.

A medical graduate of Glasgow, Leishman entered the medical service of the army in 1887, but it was not until ten years later that the call to the laboratory life came to him and we find him installed at Netley at the feet of Sir Almroth Wright and Sir David Semple. With Semple's removal to India in 1900, Leishman became assistant professor of pathology, and in 1903, with the disbandment of the Netley laboratory, he came to London to be professor of pathology at the Royal Army Medical College, a post he retained until 1913. The War gave Leishman abundant scope for his administrative qualities, particularly in the organisation and supervision of bacteriological services in France, which proved such indispensable units in the general scheme of military medicine and hygiene. When the Director-Generalship of the Army Medical Service became vacant in 1923, it was pleasant news to many that one whose reputation rested on his achievements as a scientific worker and teacher had been raised to this important post, which, we believe, Leishman was filling with great acceptance when the end came.

It is appropriate here to refer mainly to Leishman's scientific labours, two at least of which have made his name a household word in medical science. These were his modification of the Romanowsky staining procedure in 1901 and his description for the first time in 1903 of the Leishman-Donovan bodies, the specific protozoal agent of kala-azar and tropical sore and other forms of leishmaniasis which have since become known.

The method of Romanowsky staining, now so indispensable an aid to parasitological and hæmatological technique, was, when first introduced, a cumbrous and perhaps somewhat uncertain procedure. Leishman conceived the idea of securing in one stain the product obtained by the interaction of methylene blue and eosin and dissolving that product in methyl alcohol. This solution both fixed and stained the preparation at the same time, and by the addition of distilled water at a certain stage in the process, a picture was obtained in which the chromatin material present took up the characteristic Romanowsky tint.

Leishman's stain gained wide fame and use and is still largely employed, though for certain purposes modifications such as that of Giemsa are preferred. It was admittedly the use of Romanowsky staining in the form modified by himself which enabled him to obtain a clearer picture of the structural details of the curious bodies the real nature of which had perplexed him for three years. These bodies he had observed first in spleen smears from a fatal case of obscure splenomegaly invalided from Dum-Dum, near Calcutta, to Netley. That they were protozoal parasites he had no doubt when he finally published his description of them in 1903, and he hazarded the opinion, based on observations of the forms assumed by trypanosomes in the blood and organs of rats which had died of experimental Nagana infection, that the bodies pointed to the presence of trypanosomiasis in India—or at least some form of trypanosomiasis in which the fully-developed trypanosome might only rarely make its appearance in the blood stream.

The description by Leishman appeared in May 1903, and in July came an announcement from Donovan confirming Leishman's observations in certain cases of obscure splenomegaly in Madras. Shortly afterwards was reported the finding of similar bodies in tropical sore (Delhi boil) and in the disease known as kala-azar in Assam. Kala-azar, in fact, was proved, by the finding of the parasite, to have other foci outside its main home in Assam.

The writer of this notice may be pardoned for alluding to the finding of these bodies by Marchand and him in the organs of a German soldier returned from the Boxer campaign who died in a Leipzig hospital in December 1902. In their description by Marchand in March 1903, the only opinion that was hazarded was that the bodies might represent some unique form of nuclear degeneration of spleen cells in the obscure symptom-complex known as splenic anæmia—an opinion that was promptly revised when the communications of Leishman and Donovan came to their knowledge later in the year. The Leipzig case pointed to the presence of kala-azar in China, since then a well-recognised centre.

Leishman's view that the Leishman-Donovan bodies represented some form of trypanosomiasis had much to be said for it, and the subsequent discovery by Rogers that flagellate trypanosome-like forms developed from the L.-D. bodies in artificial culture, appeared to lend considerable support to the contention. The view, however, of Ronald Ross, expressed in November 1903, that the Leishman bodies represented a new genus of parasites and not a species or phase of trypanosome, proved the correct one as time went on. Leishman himself in September 1904 directed attention to the similarity of the flagellate forms found in culture of the L.-D. bodies with the herpetomonas known to be present, for example, in the intestinal tract of the house-fly. Though this interesting connexion of the L.-D. bodies in cultural phase has been kept in view for more than twenty years, it is only within recent months that the problem of transmission seems in a fair way to solution, the most probable insect vector being a species of sand-fly.

Leishman made other important contributions to tropical medicine, particularly in connexion with tick fever and the granular changes which take place in the spirochætes within the body of the tick after an infective feed. The precise significance of these "infective granules" is not yet completely understood.

The association of Leishman with Sir Almroth Wright at Netley in the closing years of the nineteenth and the early years of the twentieth century was the means of introducing him to the great problem of antityphoid vaccination, a measure now so potently vindicated by the experience of the War. In 1902 Leishman described a method of estimating quantitatively the phagocytic power of the leucocytes in infection with the view of supplementing the bactericidal tests which had been hitherto mainly employed as criteria of acquired immunity. The technique formed the basis of the method employed by Wright and Douglas (1903) in their analysis of the factors which determine the phagocytosis of micro-organisms in the presence of normal serum. The appointment by the Army Council in March 1904 of the Antityphoid Committee "to investigate the practical prophylactic and therapeutic value of current methods of immunisation against enteric fever," gave Leishman and his enthusiastic band of collaborators abundant opportunity for experimental investigation during many busy years. Questions such as the preparation and standardisation of the vaccine, the relative efficiency of vaccines prepared in different ways, their keeping quality, the antibody response to them in the inoculated, and many other cognate questions were submitted to experiment both in man and animals. Thus when the War came, all was *en train* for the prompt institution of this beneficent preventive measure.

When the War closed, Leishman became the first Director of Pathology at the War Office, a post which he held until his appointment in 1923 to be Director-General of the Army Medical Service. The influence of Leishman as a teacher and scientific worker was an asset of incalculable value to his corps, and that influence will, we trust, go on to further fruition. The fellowship of the Royal Society came to him in 1910, and many distinguished orders thereafter. His outside interests were many, and of committee and commission work he took his full share. He was a polished and ready speaker, ever a helpful and courteous colleague, and in his little leisure he found time to indulge his love of art and music and the pleasure of tending his Croydon garden.

J. C. G. L.

SIR FREDERICK MOTT, K.B.E., F.R.S.

PSYCHIATRY has suffered a very grievous loss by the death of Sir Frederick Mott on June 8. To the last he was occupied by his researches, and in spite of advancing years he was a leader of scientific thought in the allied provinces of physiological psychology and psychiatry.

The earlier work of Mott on the physiology of the central nervous system belongs to that period when there was still much to be done by the successors of Fritsch and Hitzig in the field of cortical localisation, and his researches with Schäfer are among the foundations of our knowledge of cerebral physiology. From the motor cortex he turned to the study of sensory representation, and his work with Sherrington on the apæsthetic limb was a great contribution to our knowledge of the sensory component of motor activity. His brilliant studies on the anatomy of the spinal encephalic system and the thalamic connexions of the fillet led up to the classical work on the architecture of the cerebral cortex.

Mott's interest in the pathology of the nervous system was determined by his appointment as pathologist to the London County Council Mental Hospitals in 1898. When working in the Central Laboratory, then situated at Claybury, he had access to the enormous amount of pathological and clinical material furnished by the whole group of London mental hospitals. His first great work in this field was to study the pathology of general paralysis, the one psychosis that was then recognised to be associated obviously with concomitant bodily change. Although the syphilitic origin of general paralysis had been pointed out by Krafft-Ebbing, this etiology was only accepted by a small minority of psychiatrists in Great Britain. These were the days before the Wassermann reaction, and Mott set himself definitely to prove Krafft-Ebbing's thesis by a close study of a great mass of pathological data and by clinical observations. As a result of his epoch-making research the syphilitic origin of general paralysis was proved beyond all cavil, and this paper was followed by studies on the relation of syphilis to other forms of insanity and to tabes. The whole of this work was published in the first volume of the *Archives of Neurology*, which he founded.

From his work on general paralysis Mott became firmly impressed by the idea that bodily changes are to be found in all types of psychosis, but he recognised that it was not probable that the functional disturbances of the majority of the psychoses would be shown by the relatively coarse methods of investigation practised in the pathological histology of the nervous system. He turned his attention, therefore, to the bodily mechanisms which exhibited the organic resonance to emotion in the hope that disturbances of the affective states would be sufficiently pronounced at a period of the disease when the higher centres were less affected. Dementia præcox offered the most promising field of study, and in a series of papers on the pathology of the gonads and other endocrine organs and the vegetative nervous system in this disease, he was able to demonstrate with certainty the existence of a widespread degenerative change preceding the far slighter evidences of degeneration that could be detected in the central nervous system in advanced cases. In other psychoses similar though less marked pathological changes were encountered. Mott, however, was a profound disbeliever in the attempts to relegate the psychoses into sharply-defined classes. He considered that though the signs of structural impairment were most obvious in dementia præcox, there was not clinically or pathologically any hard-and-fast line between this and other psychoses. He was well aware that the methods of pathological anatomy could only furnish evidences of relatively gross changes, and he turned to the study of the biochemistry and physics of the central nervous system.

Though Mott later greatly modified the conclusions that he drew from the attempts which he made with Halliburton to demonstrate the existence of products of nervous degeneration in the cerebral spinal fluid, this work, which he published in his Croonian Lectures, was important as the starting-point of many subsequent investigations into the chemical pathology of the nervous system.

As a consultant neurologist to a clearing hospital for war neuroses Mott's attention was diverted for a time from the psychoses to the neuroses. A study of the previous histories of the various sufferers from war neurosis convinced him that in the overwhelming majority of the cases there was definite evidence of the pre-existing functional instability of the nervous system. He predicted that an investigation into the physiological activity of the mechanisms of the motor system in such cases would reveal functional abnormalities, and work done in his laboratory from the point of view of the physiological psychologist certainly tended to support this view. Mott considered, then, that a neurosis was the response of an abnormally constituted organism to environmental stress which could be safely encountered by the normal individual, and he looked for such abnormalities of function rather in the emotional mechanisms and the various glandular organs that subserve them than in the higher nervous strata.

These views on the pathogenesis of the psychoses and neuroses are only now beginning to make themselves felt. At the time at which they were published, students of psycho-pathology, owing to a curious confusion of thought, seemed to have regarded the formulation of the anatomical and physiological disturbances found in the psychoses as an attempt to translate thought into terms of nervous mechanism. The real importance of this work is that it enables us to build up a pathology for the psychoses on the lines that have already been firmly established for the various toxæmic psychoses and for syphilitic insanity.

In the actual study of disorders of conduct Mott followed the methods of the less extreme school of behaviourism. He thoroughly distrusted the results of the various schools of psycho-analysis on methodological grounds, but he did not consider that his discoveries on the pathology of the nervous system had any direct bearing on the admissibility of their views. He considered that the majority of the pathological changes he had discovered in insanity are congenital, and instituted a very extensive inquiry into the genealogy of the cases in the London mental hospitals. As one of the fruits of his investigation he enunciated the "Law of Anticipation," in accordance with which the onset of the psychotic symptoms appears earlier in the successive generations of a degenerate family, and thus ultimately, owing to the production of infertile juvenile psychotics, the tainted stock disappears. He had more faith in the efficacy of this natural method for the elimination of the mentally unfit than in segregation or sterilisation. He pointed out that in the earlier generations of an insane family the psychosis is as a rule not evident until after much damage has been done by the breeding of tainted progeny.

Mott's work in the field of hospital hygiene is less widely known, but it is in a great measure due to his energy and teaching that dysentery in mental hospitals is almost a thing of the past.

The great work that Mott did for the teaching of the scientific aspects of psychiatry constitutes one of his greatest services to society. He was fortunate in possessing the esteem and friendship of a great clinical psychiatrist, Dr. Henry Maudsley, and when Maudsley proposed to found a hospital for the investigation and treatment of the early forms of mental disease, it was in order that it should be under the supervision of Mott that he gave the necessary endowments to the London County Council. After many years of difficulty, the Maudsley Hospital for Early Mental Diseases was opened at Denmark Hill, and the Central Pathological Laboratory was transferred there from Claybury. It was here in the concluding years of his service as pathologist to the London Mental Hospitals that Mott instituted a school of psychiatrical medicine, one of the functions of which is to prepare the younger psychiatrists for the examination for the Diploma of Psychological Medicine, which has been instituted thanks to his efforts. Mott continued to teach enthusiastically in the Maudsley Hospital to the end, and acted as the director of a similar school of psychiatry in Birmingham, and he was on a visit thither when he had the cerebral seizure from which he died.

Mott was at the disposal of any one who sought his advice, and did much to assist younger men by suggestions and criticism. He was possessed of a sturdy common sense and preserved to advanced years a keen scientific acumen combined with a phenomenal receptivity for new views and facts. He was a man of wide culture, and his great kindliness and sincerity endeared him to all.

SIR HENRY MORRIS, BART.

SIR HENRY MORRIS, who did more than any man of his time to open up the field of renal surgery, died in London on June 14 in his eighty-third year. On February 11, 1880, when he had become full surgeon on the staff of Middlesex Hospital, he removed a stone from the kidney of a patient, this being the first time that a deliberate operation had been performed for such a purpose. The operation was successful, and has become the type of a procedure now adopted by surgeons all the world over. When he gave Hunterian Lectures at the Royal College of Surgeons in 1898, he was able to cite the results he had obtained from 367 operations carried out on the kidney. It is true that Gustav Simon of Heidelberg performed the first operation for the removal of a diseased kidney in 1869, and that this operation had been frequently and successfully repeated before 1880, but it was Morris who demonstrated that one of the commonest of disorders from which the human kidney suffers—the presence of renal concretions—can be safely cured by surgical procedure.

Sir Henry Morris was, however, a general surgeon in the best sense of the term and contributed to all branches of surgical art. He came of Welsh ancestry; his grandfather was a surgeon in Oswestry, and his father in Petworth. He was dark in hair and complexion, and massively framed in head, body and limbs, a good exemplification in the flesh of the type which Mr. "Punch" has chosen to represent as "John Bull." He was a man of decided opinion, resolute in his policy, never afraid of opposition, and public-spirited to a high degree—often seeking the columns of the *Times* to guide opinion in educational, medical, social and political matters.

Epsom College and the University of London provided the opportunities of Sir Henry Morris's education, and he repaid both by giving them his unstinted services; he took an abiding interest in the welfare of

Epsom College, acting as its treasurer for many years. His medical education was obtained at Guy's Hospital, but his life's work was spent in the wards of Middlesex Hospital, to which he became assistant surgeon in 1871. There he did much to direct attention to the urgent need of research into the nature of cancer, and took an active part in founding the Imperial Cancer Research Fund.

Sir Henry Morris was also an anatomist. He lectured on human anatomy in the Medical School of Middlesex Hospital, and in 1893 edited a very successful "Treatise on Human Anatomy." An earlier work on the "Anatomy of Joints" is still a book of reference; it contains many original observations.

In 1893 Sir Henry was elected to the council of the Royal College of Surgeons of England, serving as president for three years, 1906, 1907, 1908, a baronetcy being conferred on him then. He delivered the Hunterian Oration in 1909, in which he compared the respective merits of the inductive and deductive methods of philosophy. He served on the General Medical Council, becoming treasurer to that body, and in 1910 was elected president of the Royal Society of Medicine. He was one of the outstanding figures in modern surgery, and a leading authority on medical education.

WE regret to announce the following deaths:

Prof. E. Babák, professor of physiology and general biology in the Masaryk University and Veterinary School in Brno, known for his work on the regulation of respiratory movements and also on the influence of endocrine glands on amphibian metamorphosis, on May 29, aged fifty-three years.

Prof. J. J. Flather, head of the department of mechanical engineering at the University of Minnesota and vice-president in 1902 of Section D of the American Association for the Advancement of Science, on May 14, aged sixty-three years.

Dr. C. Hering, a pioneer in electro-chemistry, who was one of the founders of the American Electrochemical Society in 1902 and in the same year began a movement which resulted in the foundation of *Electrochemical Industry*, on May 10, aged sixty-six years.

Prof. A. Magnin, formerly professor of botany and director of the Botanic Garden, University of Besançon, and a gold medallist of the French Geographical Society, aged seventy-eight years.

Prof. W. F. Shanks, professor of physiology in the University of Leeds since 1923, and formerly lecturer in physiology in the University of Glasgow.

Prof. V. A. Steklov, professor of mathematics at the University of Leningrad and vice-president of the U.S.S.R. Academy of Sciences, on May 30, aged sixty-one years.

News and Views.

SITTING in committee on the Finance Bill on June 21, the House of Commons rejected a clause moved by Mr. Withers (University of Cambridge) providing that a university, a college, or hall in a university, a public school, and any educational institution receiving a Government grant, should be exempt from income-tax in respect of any profits forming part of its income which were applicable to educational purposes only. The Chancellor of the Exchequer opposed the motion, though he stated that he was not satisfied with the present state of the law on the subject of the exemption of 'charities' exempt from income tax. The motion arose on the decision recently given by the House of Lords that a public school making a surplus is liable to taxation as earning profits, but the general question is closely related to the letter from the president and the treasurer of the Chemical Society which appeared in our issue of June 19 and their further letter in this present issue.

THOSE engineers who hold that the concentration and standardisation of electrical power supply in Great Britain is the best policy to adopt, and are weary of the somewhat fruitless discussions on points of administration taking place during the Committee stage of the present Government Bill, will now be able to point to the ever-growing electrification of Germany in support of their views. Plans have already been made for the inter-connexion of the existing power stations in Germany by overhead 'feeders' on a gigantic scale. In the past the production of electrical power in Germany has developed on individualistic lines. The largest power works belong to the Reich, which produces more than a thousand million units per annum solely for profit. There are very many stations, however, of much smaller size which are very uneconomical. In some cases they burn peat fuel, and supply only a few hundred consumers. Owing to the great distances involved, it will be necessary to use very high pressures, and experiments are proceeding with insulators for use on lines with transmission pressures of 220 and 380 kilovolts.

Two main schemes for electrification in Germany have been planned. The first proceeds from the water-power stations at the Vorarlberg in South Germany to Hamburg, and the second from the same source through the Central German lignite fields and Berlin to East Prussia. A length of about 100 kilometres from the Goldenbergwerk to the Wesel is now working at 110 kilovolts, but double this pressure will probably become the standard. As chains of insulators are used there is no difficulty about insulation. With these high pressures it is necessary to use overhead wires of large diameter, otherwise brush discharges—the so-called corona—appear on the wires and lead to a serious loss of power. The conductors therefore are generally made of aluminium and are hollow. Some of the cable manufacturers make the conductors of copper, the outer cylindrical shell being supported by a helix of copper tape wound inside the hollow. In California, 220-kilovolt transmission over 243 miles has been in successful operation for the last two years. The cables are of aluminium with a steel core and are supported by chains consisting of twelve insulators.

REPORTS have appeared recently in some of the newspapers of a new steel, described as 'F' steel, which was stated to have great advantages for structural work, a saving of 40 per cent. in weight and 30 per cent. in cost as against ordinary mild steel being claimed. No particulars were given, but the manufacturers were said to be the Freund Smelting and Machine Manufacturing Co., of Berlin, the patent having been acquired from the Swiss metallurgist Bosshardt. A paper in *Stahl und Eisen* for April 15 gives a detailed account of the steel, from which it appears that Messrs. Freund were not in any way responsible for the newspaper statements. The steel is not a new one, but is a high-silicon alloy of a kind already known to metallurgists. Neither is the Bosshardt furnace essential to its manufacture, steel of similar properties having been made in ordinary steel furnaces. Messrs. Freund have allowed the particulars to be published, an investigation of its properties having been made by them in collaboration with the Verein deutscher Eisenhüttenleute. The steels examined contain from 0·67 to 1·1 per cent. of silicon, with low carbon, about 0·10 to 0·14. This gives an increased elastic limit and breaking strength as compared with simple carbon steel, whilst the ductility is not reduced. In the interesting volume of Sir Robert Hadfield on "Metallurgy and its Influence on Modern Progress" (see NATURE, February 6, p. 187) the use of a similar steel, but with a rather higher carbon content, in the construction of the *Mauretania* and *Lusitania* in 1907, is described. The introduction of these steels into shipbuilding was due to the late Mr. John Spencer, the composition having been arrived at as the result of the original investigations on silicon steels by Sir Robert Hadfield.

WHEN certain adhesive tapes such as are used for insulating purposes are unrolled, a bright greenish luminescence appears over the region of immediate separation occupied by the suddenly extended threads of the viscous adhesive medium. A letter on this subject entitled "Bioluminescence" was communicated by Dr. J. W. French to NATURE of June 20, 1925, p. 944, the title being suggested by the resemblance to the greenish light emitted by certain insects. Only a few kinds of insulating tape exhibit the phenomenon, such, for example, as the black "Chemico" British tape and the white Italian tape. According to Prof. Elmer O. Kraemer, of the University of Wisconsin, Madison, the light is produced when the adhesive tape is separated from the ends of the film proper in camera roll films. There are, however, many types of roll film that do not act in this way. It can be demonstrated that the effect is associated with particular adhesives and not with the film itself. Similar luminescence sometimes appears when the adhesive tape is stripped from the joint of the tin in which unexposed kinematograph film is usually contained. It occurs in the adhesive between the tape and the tin.

IN some further experiments Dr. French has found that excellent results are obtainable from the use of ordinary rubber vulcanising solution, provided it is in a suitable physical condition of tackiness, which may be varied by treatment with sulphur. The adhesive threads must not be too extensible: on the other hand they must not be too short or brittle, for if the experiment is repeated with the pieces of tape which in the first instance have produced a bright light, the luminosity will be fainter and the threads shorter. If the pieces, however, are kept pressed together for a day or two, the threads will be of more normal length and the light may be as strong as before. There thus seems to be some close connexion between the rate of extension up to the breaking point and the luminosity. Prof. Eligio Perucca, Laboratorio di Fisica Sperimentale della R. Scuola di Ingegneria, Torino, who in his lectures on experimental physics includes the phenomenon in question as a type of luminescence, states that, if one of the tapes is connected to a gold-leaf electroscope, it will be found that the stripping operation produces an electrostatic charge of three or four units at a pressure of about 200 volts. In his original communication, however, Dr. French stated that the light appears undiminished in brightness when the tapes are unrolled under water or in a Bunsen flame, so it can scarcely be assumed that the electric charge is the cause of the luminosity.

THE new Pharmacological Laboratories of the Pharmaceutical Society were opened by the Minister of Health, the Right Hon. A. Neville Chamberlain, on Wednesday, June 16. The chair was taken by Mr. P. F. Rowsell, immediate past president of the Society, during the tenure of whose presidency the opening ceremony should have been performed at the beginning of May. In his speech Mr. Rowsell referred to the passage into law of the Therapeutic Substances Act and the necessity which arose for the existence of a laboratory where those manufacturers who wished could have tested the products which were placed upon the schedule of the Act from time to time. Dr. J. H. Burn, Director of the Laboratories, described in more detail the functions which it is hoped the laboratories will subserve, and laid special emphasis upon the research into methods of standardisation which will be vigorously carried on in the future. He referred also to the international importance of the work which has been carried out since the War on this subject in the laboratories of the Medical Research Council under the direction of Dr. H. H. Dale, adding that it is gratifying to realise that Great Britain has taken the lead in introducing methods for the biological standardisation of drugs. Dr. Burn also mentioned a third reason for the founding of these Laboratories, namely, in order to afford an opportunity for the training of pharmacists in methods of biological standardisation. Mr. Chamberlain, in declaring the Laboratories open, referred to the many and varied duties of a Minister of Health, all questions relating to the prevention of disease as well as to the purity of the drugs used in treating it coming within his province. Sir Humphry Rolleston, moving a vote of thanks to Mr. Chamberlain, referred to the interest taken by the late Mr. Joseph Chamberlain in the health of the British possessions in the tropics. Mr. Edmund White, chairman of the Society's Scientific Advisory Committee, seconded the vote of thanks, and Mr. Chamberlain briefly replied. After the ceremony, the company adjourned to the Laboratories, where

Dr. Burn demonstrated methods used in the standardisation of the digitalis group of drugs, and of ergot and pituitary extract.

UNDER the will of the late Sir Winthrop Hackett, first Chancellor of the University of Western Australia, the sum of 50,000*l.* was left to the University and the Anglican Church. Three-eighths of the money was to be devoted to providing scholarships; three-eighths to be invested until it accumulated to 40,000*l.* when a Winthrop Memorial Hall was to be erected, and one-quarter was left for the purpose of the erection and maintenance of an Anglican University College with a chapel attached thereto. Not content with these proofs of his devotion to the University, Sir Winthrop bequeathed the balance of his residuary estate to the same two bodies in the same proportions and in the same manner. Sir Winthrop died in 1916, and the trustee of the estate, Mr. Alfred Langler, has informed the University Senate and the Diocesan Trustees that he will shortly have paid off all liabilities and all the numerous legacies with the exception of those of the University and the Anglican Church. The University and the Anglican Church, for the purposes of the trust alluded to in Sir Winthrop's will, are now the sole heirs of the very valuable estate left by Sir Winthrop Hackett. That estate includes the principal daily newspaper in Western Australia and a weekly paper, both of which have been 'flourishing' for many years. The bequest is without doubt one of the most munificent that has ever been made to an Australian university. To Sir Winthrop Hackett is due in large measure the starting of the University of Western Australia, and it will be remembered that he, during his lifetime, endowed the chair of agriculture.

THE political significance of recent events in Poland is outside the scope of this journal, but the outcome, the election of Prof. Ignace Moscicki as the new President of Poland, is noteworthy in that Prof. Moscicki is a distinguished man of science who has also been actively concerned in industrial chemistry. We are indebted to the *Chemical Trade Journal* for some details of his career. Prof. Moscicki is best known for a process for the fixation of nitrogen by the arc method, which was elaborated while he was director of the electro-technical and electro-chemical laboratories at the University of Freiburg. In 1912 he was appointed to a similar post at the University of Lwow which he held until after the War. Since then he has been head of the Polish State Nitrogen factory at Chorzow, where the manufacture of cyanamide has been developed, the monthly output now reaching about 10,000 tons. For five years he was a student in London. Prof. Moscicki has a reputation as a scientific worker and as an administrator, and there is little doubt that the discipline of his early training will serve him well in his difficult task of guiding the fortunes of a modern European State.

A NUMBER of paintings on ivory by Winifred Brunton, with the collective title "Africa, Ancient and Modern," is now on view at the Arlington Galleries, 22 Old Bond Street. Mrs. Brunton, as those who visit this exhibition will appreciate, has devoted much time to the study of Egyptian antiquities from the artistic point of view, and is responsible for the beautiful coloured plates illustrating the "Portraits of the Kings of Egypt." In the collection now on view more than half the subjects are drawn from ancient Egypt. All show a wonderful and accurate sense of colour, which finds full play in the reproductions of personal ornaments, although "A Temple Vase" and the lotus cup from the Cairo Museum will bear comparison with any. Of the heads, "An Unknown King," reconstructed from a statue in the Cairo Museum, and "Amenemhat III." are remarkable conceptions of force of character. There are two very charming pictures of dancers, the "Wind in the Reeds" being especially pleasing in composition and colour. The paintings from South and East Africa include several subjects of ethnographic interest. The reconstruction of Rhodesian man is more convincing than some attempts that have been made to clothe this interesting relic with flesh. The exhibition was opened by Mr. Robert Mond on June 21 and will remain open until July 2.

COMMEMORATION DAY at Livingstone College, London, E.10, was celebrated on Wednesday, June 9. The Right Rev. the Lord Bishop of Chelmsford presided, and in the course of his address said that the College exists to help all missionary societies of the church and churches; that those who go forth may at least have some kind of knowledge both as to the management of their own health and of that of other people. Missionaries trained at the College are a tremendous help to the people to whom they go if one looks at it from only a humanitarian point of view. The Rev. B. T. Butcher, of the London Missionary Society, an old student of the College, referred to conditions in New Guinea. When he first went out there, there was but one cure for the loathsome disease of yaws, and in most cases it took more than a year to effect a cure; now it can be dealt with in a short course of treatment. In his opinion, yaws will be almost unknown round the coast of New Guinea in ten years' time, and Livingstone College will have played a part in making it unknown. Mr. R. L. Barclay, hon. treasurer of the College, referred to the work which had been done for the College by the late Dr. Harford, and stated that they had already received 770*l.* towards a fund of 3000*l.* which was being raised in his memory. The Principal of the College mentioned that old students are in Sierra Leone, Labrador, Siam, North Africa, and many other parts of the world; last year 103 students entered the College, including the short course and vacation course students.

IN the *Journal of the Franklin Institute* for May, Dr. C. E. K. Mees of the Eastman Kodak Company contributes an article on the colour sensitivity of photographic materials, in which he traces the subject from its very beginnings down to the present day, especially with regard to its practical aspects. Modern panchromatic plates and films enable exposures of one-fiftieth of a second to be given through the tricolour red and green filters with apertures so low as $f/4·5$, as is necessary in colour kinematography and in aerial photography with the red filters which have to be used to do away with the fogging effect of atmospheric haze. A very instructive diagram shows that in the period 1904–1919, photography of the spectrum was possible from a little over λ200 to a little beyond λ700, in 1919–1925 sensitiveness to the infra-red was extended to rather beyond λ800; while at the present time it is possible "easily" to photograph to rather beyond λ900, and "with difficulty" to photograph from practically λ100 or even λ50 to λ1000, the "difficulty" being the long exposure necessary, and the need for vacuum apparatus when using the shorter wave-lengths. The paper includes many interesting illustrations, one being of the planet Mars to show the difference between the results when an ordinary plate and when an extreme red-sensitive plate and filter are used. The latter shows detail that is invisible in the other, and shows the actual surface of the planet, while the ordinary plate shows a much larger disc due to the atmosphere that surrounds it. Dr. Mees finally refers to the work of Barnard and Gye on the cancer virus, who by using a wave-length of λ257 and a microscope with quartz lenses of numerical aperture 1·25 have obtained a resolving power of 0·11 μ instead of the visual resolving power obtainable of 0·2 or 0·16 according to the light used. It seems questionable whether there is any practical gain, especially considering the great difficulty of using the apparatus. "Barnard, however, is undoubtedly trying to get shorter wave-lengths."

THE forty-fifth annual meeting of the Society of Chemical Industry, which will be held in London during the week July 19–23, is to assume the character of a Congress of Chemists, and as such will be supported by a large number of societies connected with chemistry. On July 19, in the Mansion House, Lord Balfour will deliver the third Messel memorial lecture in the presence of the Duke of York and the Lord Mayor; earlier in the day Sir Frederic Nathan will give his presidential address to the Institution of Chemical Engineers on "Industrial Efficiency and the Elimination of Waste," and Sir Max Muspratt will open an exhibition of British chemical plant. With the exception of these two items, which will take place in the Central Hall, Westminster, and of an exhibition of chemical apparatus at the Institute of Chemistry, all the meetings and most of the social functions will be held in the Hotel Great Central, London, N.W.

THE scientific meetings in connexion with the forthcoming meeting of the Society of Chemical Industry will be open to chemists without restriction and will include discussions on corrosion, hormones, and "Chemistry House" (July 20); power alcohol, the influence of particle size in the paint and rubber industries, under the chairmanship of Sir William Bragg (July 22); fat-extraction by solvents, and solid smokeless fuel (July 23). Among the papers to be read, those on the experimental study and use of hormones, by Dr. H. H. Dale, and sugar from wood, by Dr. W. R. Ormandy, appear to be of exceptional interest. Addresses by Sir Josiah Stamp and Sir Max Muspratt are announced for July 21. There will be a large number of excursions and visits to works, and the many social functions will include a garden party in the Royal Botanic Gardens, by invitation of Sir Alfred and Lady Mond, the annual dinner of the Society of Chemical Industry, a smoking concert, dance, and conversazione. The Chemical Industry Club is offering honorary membership to all attending the Congress. Full particulars and tickets are to be obtained from the Society of Chemical Industry, at Central House, Finsbury Square, London, E.C.2.

SIR HUMPHRY ROLLESTON, Bart., Regius professor of physic in the University of Cambridge and lately president of the Royal College of Physicians, has been awarded the Gold Medal of the British Medical Association.

FURTHER details of Miss Garrod's discovery of a skull, presumably of Mousterian age, at Gibraltar, tend to confirm the first impressions of its importance. In addition to the frontal bone another large piece of bone was found, but owing to the hardness of the matrix in which it is imbedded it is impossible yet to say whether it is the parietal or the occipital. Decision on this and other points must wait until it has been cleared. The hardness of the matrix has by no means been entirely a drawback, as it has ensured the recovery of the fragments in pieces of considerable size.

IT is announced that the Medical Research Council, on behalf of the Rockefeller Foundation, has made the following awards of medical fellowships provided by the Foundation and tenable in the United States of America during the academic year 1926–27: Dr. G. Bourne, St. Bartholomew's Hospital, London; Mr. H. W. B. Cairns, London Hospital; Miss R. E. Lucas, Maudsley Hospital, London; Mr. R. D. Mackenzie, University of Edinburgh; Mr. C. F. A. Pantin, Marine Biological Laboratory, Plymouth, Dr. A. F. B. Shaw, University of Durham; Dr. J. C. Spence, Royal Victoria Infirmary, Newcastle-on-Tyne; Mr. H. E. C. Wilson, University of Glasgow.

THE research steamship *William Scoresby* is now being fitted out at the Humber Dock, Hull, and is expected to be ready for sea at an early date. She is a small vessel of the whale catcher type, her principal dimensions being: length, 125 ft.; breadth, 26 ft.; depth, 14½ ft.; draught, 13½ ft. The *William Scoresby* will be employed, in conjunction with the R.R.S. *Discovery*, and will operate principally in tropical and antarctic regions. Her duties will consist generally in the marking of whales, steam trawling and other marine biological investigations. The ship's company will include two scientific workers, the master, four officers, and fourteen petty officers and men. The whole cost of the vessel will be met from the funds of the *Discovery* Expedition which are derived from the revenues of the Falkland Islands Dependencies.

THE part enacted by the house-fly as a carrier of disease organisms and the necessity for efficient measures preventing the breeding of this insect are facts of prime importance from the point of view of public health. We therefore welcome the appearance of a second edition of the illustrated brochure on this insect which has been recently issued by the British Museum (Natural History). The author, Major E. E. Austen, has revised and expanded the text of the first edition and has brought the pamphlet thoroughly up-to-date Its full title, "The House-Fly, its Life-History, Importance as a Disease Carrier, and Practical Measures for its Suppression," sufficiently explains its scope. It may also be added that the author deals with the insect under other conditions besides those met with in the British Isles, and has incorporated the results of experience gained through the operation of sanitary measures in the War. The pamphlet is obtainable either from the Natural History Museum, South Kensington, or through booksellers, price 1s.

Applications are invited for the following appointments, on or before the dates mentioned:—A demonstrator in the Department of Inorganic and Physical Chemistry, Bedford College for Women—Secretary, Bedford College, Regent's Park, N.W.1 (July 3). Part-time lecturer in sociology, Bedford College for Women—Secretary, Bedford College, Regent's Park, N.W 1 (July 3). Research chemists for the Fuel Research Station, East Greenwich—Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (July 3). Analysts for work in connexion with the Physical and Chemical Survey of the National Coal Resources of Great Britain—Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S W.1 (July 3). Half-time assistant in the Department of Mathematics, University College of Swansea—Registrar, University College, Swansea (July 9). Two junior scientific officers at the Royal Aircraft Establishment—Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (July 10). Assistant lecturer in physics, University College of Wales—Secretary, University College, Aberystwyth (July 13). Lectureship in chemistry in the University of Durham—Registrar, Armstrong College, Newcastle-upon-Tyne (July 17). Assistant agricultural chemist in the Department of Science and Agriculture, Barbados—Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1 (July 31). Senior laboratory assistant in the Department of Entomology, London School of Hygiene and Tropical Medicine—Secretary of the School, 23 Endsleigh Gardens, W.C.1 (July 31). Head of the Chemistry Department, Borough Polytechnic Institute—Principal, Borough Polytechnic Institute, Borough Road, S.E.1. Several inspectors of agriculture for the Sudan Government—Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1.

Our Astronomical Column.

Recent Solar Activity.—For several weeks there has been an absence of very large sunspots, although smaller ones, averaging half-a-dozen daily, have been of interest to observers with moderate telescopic means In addition, faculæ at both limbs of the sun have been present on most days, some of the areas being of considerable extent. Traces of the faculæ related to the great spot of last December and January in north latitude 22° were seen about a fortnight ago. On June 21, a group of spots, the development of which had been watched since June 16, was of sufficient size to be a naked-eye object on the disc. The group consisted of a roughly circular spot as leader closely followed by a close cluster of small spots, which on some days linked up with one another to form a composite companion to the leader On June 15, Mr. Newbegin, observing with his spectroscope at Sutton, Surrey, noted a metallic prominence (that is, one having a spectrum containing metallic lines) at position angle 63°, which corresponds almost exactly with the position of the newly forming spots then at the sun's east limb. This prominence, of the 'rocket' or 'splash' type, appeared as if the gases were being expelled from a common centre. Such prominences, according to Evershed and other observers, are very frequently found connected with sunspots, either during their active development, or at other times when great changes are taking place.

Particulars of the large spot are given below:

No.	Date on Disc	Central Meridian Passage.	Latitude.	Area.
7	June 16-(28)	June 22·0	25° N.	1/1400

(Area expresses the proportion covered of the sun's hemisphere.)

Neptune's Satellite.—Prof. Eichelberger's and Mr Arthur Newton's exhaustive researches on this satellite have already been mentioned in Nature. Their paper is printed in the March issue of *Mon. Not. Roy. Ast. Soc.*, and deserves a further note. It is curious that though no certain markings have been seen on Neptune's surface, we now know the position of its axis nearly as accurately as that of Mars. The position of its north pole is given as R.A. 295°·2, N. Decl 41°·3 (equinox 1900·0): the pole of the satellite's orbit describes a circle of radius 20°·1 in 585 years, the annual motion being 0°·62. The observations indicate a considerably greater motion for the major axis of the satellite's orbit, from 1°·5 to 3°·0 per annum. It moves in the opposite direction to the node, as it should, but the observed motion is probably too great. Owing to the very small eccentricity, about 0·005, it is very much more difficult to determine the position of the apse than of the node. Dr. J. Jackson deduces 1/66 and 19 hours as the probable values of the compression and rotation period of Neptune.

Temperature of Mars.—*Astr. Nach.* No. 5448 contains an article by W W. Coblentz comparing the measures made by Lampland and himself at the Lowell Observatory with those made by Pettit and Nicholson (100-inch at Mt. Wilson). It is noted that the receiver used by the latter covers a Martian area 50 per cent. larger than that used by the former; this would make the measures more nearly average ones for the whole surface, and less affected by the particular regions in view. The measures show that dark areas are hotter than bright, and that the afternoon side of the planet is hotter than the morning side; the latter point is not so plainly indicated in the measures of Pettit and Nicholson, but terrestrial analogy makes it reasonable. Radiation near the east and west limbs was found to be respectively one-third and one-half of that at the centre The article closes with a note of satisfaction that the two sets of observations are on the whole accordant.

Research Items.

English Gypsy Folk Medicines.—Mr. T. W. Thompson, in the *Journal of the Gypsy Lore Society* (Ser. 3, Vol. 4, Pt. 4), publishes some notes on the remedies used by gypsies for both human beings and horses, which are of some interest in view of the reputation which this people has long held for their skill in the art of healing. The information was obtained mainly from members of the Smith and Boswell families. Generally speaking, medicines made from herbs are preferred, and the list given includes forty-seven wild plants held to be efficacious for various diseases. Among them are hemlock and foxglove, which were recognised as dangerous plants, as also were monkshood and nightshade, and only used in weak infusions. Of the fungi, those growing in woodlands were regarded with suspicion, but of those growing in the open several varieties were sometimes eaten. One informant had a preference for simples; another preferred a number of ingredients. Though some of the herbal remedies can be justified in the light of modern knowledge, others rest on the doctrine of signatures which attested that plants and minerals indicated by their external characteristics the diseases for which Nature intended them as remedies. This applied also to the animal kingdom, *e.g.* hedgehog's fat was used for earache or a slight deafness, the skin of a supple eel for stiff joints. Other remedies provide examples of a symbolic transference or rebirth. For asthma the sufferer caught a trout alive, breathed three times into its mouth and put it back into the water. A spider was hung in a bag around the neck of a sufferer from ague, and as the spider died the ague left him. Hair from the cross on a donkey's back, skeleton feet of hedgehogs and moles, pieces of red cotton and wool are among the prophylactics against various diseases.

Californian Archæology.—The results of an examination of relics of the Indian tribes formerly inhabiting the Southern San Joaquin Valley, California, by E. W. Gifford and E. Egbert Schenck, have been published as Pt. 1 of vol. 23 of the *University of California Publications in American Archæology and Ethnology*. The geographical features of the Valley which have determined the character and extent of human occupation have been the lakes Tulare and Buena Vista. The general aridity of the valley and the variable water level which, at any rate in Tulare, ranges from 220 feet to absolute dryness, not only determined the site of occupation, but also in all probability prevented any very extensive or dense occupation. Presence of the Spaniards in other areas added fugitives to the population, and this and other causes have effected an extensive mixture of race and culture. The relics obtained from surface finds and excavation of burial- and camp-sites represent a great variety of artefacts, of bone and horn, steatite, chipped stone, ground stone, unworked stone, textiles and cordage, pottery and wood. Forty human crania were obtained which belonged to two types: the San Joaquin sub-type of the Californian type, short-faced and broad-nosed, and the Buena Vista type, relatively long-faced and narrow-nosed. The southern part of the San Joaquin Valley lies in an area the cultures of which have not yet been described. There is a generic resemblance between the culture of the San Joaquin area and the Santa Barbara area, but the two centres of the San Joaquin Valley, the Alpaugh and the Lake regions, have certain points of resemblance to the Santa Barbara culture which are mutually exclusive. This suggests independent lines of transmission, the Alpaugh possibly representing an earlier phase of the Santa Barbara culture. Certain features, such as the bags, the ceremonial use of human hair cordage, and of ground crescentic stones for girls' puberty ceremonies, point to Southern California.

Intestinal Parasites of Ruminants.—M. J. Triffitt records (*Protozoology*, No. 2, Jan. 1926) the results of examining the fæces of certain ruminants in the London Zoo. She found in the sable antelope from South Africa, and in a pair of common waterbuck from East Africa, an Entamœba which closely resembles and is probably specifically identical with *E. ovis*. Both active forms and cysts were present. Uninucleate cysts of some hitherto undescribed species of Entamœba are recorded from the fæces of an eland. The author also describes sporozoan parasites found in the intestinal wall of Bennett's wallaby. Two of these are closely allied to or identical with *Ileocystis macropodis* and *Lymphocystis macropodis* respectively, which the author considers should be ranged under the genus Globidium. One of the other parasites is an Eimeria (*E. macropodis*), the various stages of which are described.

Flagellates in the Latex of Asclepias.—*Herpetomonas elmassiani* is the only species of latex-inhabiting herpetomonad in the United States, and it has been found in great numbers in the common milkweed, *Asclepias syriaca*, in Maryland and New Jersey. Further studies on the relations of the flagellate to its plant host have been carried on by F. O. Holmes (*Biol. Bull.*, 49, 1925). He shows that the flagellate is confined to the latex system and that the Herpetomonas is intracellular but not intracytoplasmic. The latex is secreted into the general cell vacuole of the latex duct and it is in this that the flagellates occur. No other cells were found to be infected. A red and black hemipterous insect, *Oncopeltus fasciatus*, is suspected of being the insect host of *H. elmassiani*, and the flagellates were found in the trilobed salivary glands of this insect, chiefly lining the lumen of the dorsal lobe; a few were present in the anterior lobe, but none in the ventral lobe. Search for the flagellates in the intestine of the insect gave negative results.

Tidal Data for the Antarctic.—A reprint has reached us of the reduction by Dr. A. T. Doodson, The Tidal Institute, University of Liverpool, of the tide gauge records made at Cape Evans, in the Antarctic, by Mr. Nelson during 1921–22 (June–January). The reprint appears to be an excerpt from a volume collecting the results of the expedition, but bears no indication of its origin and gives no mention even of the name of the expedition. This was the third expedition wintering on Ross Island, and comparison is made of the amplitudes and phases of the principal tidal constituents (S_2, M_2, K_1, O_1) derived from the three expeditions, the others being those of the *Discovery* (1902) and the *Nimrod* (1907), all of which had their stations within a few miles of one another. The three sets of results are in very satisfactory agreement, and the tides in this small region of the Antarctic may be considered adequately known.

Hydrographical Conditions in the Baltic.—A survey of the hydrographical conditions in the northern part of the Baltic has been carried out during the summers of 1922, 1923, and 1924 by Finland and

Sweden working in co-operation, the region at the entrance to the Gulf of Bothnia having received the greatest attention. The results are recorded in the following publications recently received: Havsforskningsinstitutets Skrift. No. 30: *Thalassologische Beobachtungen im Ålands- und Schärenmeer im Juli 1922 und Juli 1923.* Herausgegeben von Rolf Witting und Hans Pettersson. Pp. 39. 7 Fmk. No. 32: *Talassologiska vårexpeditionen 1924. Referat: Die thalassologische Terminfahrt im Jahre 1924.* Av Risto Jurwa Pp. 27. 4 Fmk No. 34: *Regelmässige Beobachtungen von Temperatur und Salzgehalt des Meeres im Jahre 1923.* Von Gunnar Granquist. Pp. 54. 10 Fmk. No. 36: *Dagliga vattenståndsuppgifter 1923. Referat: Tägliche Wasserstandsangaben 1923* Av Henrik Renquist. Pp 46. 8 Fmk. (Helsingfors: Statsrådets Tryckeri, 1925.) Continuous measurements for several days were made by means of current meters at a number of positions where the physical conditions of the water, including the rate of evaporation and the change in water level, together with the meteorological conditions, were also observed. Currents of ¼ to ½ mile per hour were met with in the neighbourhood of the Aland Isles, running usually northward into the gulf and apparently not dependent upon the winds during the period of the survey. A south-going stream ran along the Swedish shore. No conclusions are drawn from the numerous data and no review of the conditions met with are included in the published records.

THE BATH SPRINGS.—Dr R. H. Rastall in the *Geol Mag.* for March 1926 reprints his interesting article on the geology of the Bath springs from "The Book of Bath," 1925. The temperature of the waters is about 70° F. above that of normal spring water, indicating that the ultimate source must be at least 5000 feet below the surface. This deduction, and the saline character and radioactivity, lead to the conclusion that the Bath and similar thermal springs in other countries are fed by deep-seated sources of igneous origin. The uprise of such waters involves the existence of pronounced fractures, and in the case of Bath it is not difficult to account for the existence of suitable fractures. The east and west lines of folding and fracture of the highly disturbed Mendip region and the similar north and south lines of the Malvern disturbances cross in the neighbourhood of Bath, thus producing lines of particularly easy penetration through the older rocks. The fractures, however, were produced before the Triassic and Jurassic beds were deposited, and the clays of the latter system seal up the water to some extent. Borings which have passed through the Rhætic clays encountered red sands from which hot water flowed. Thus the exact points of outflow at the present surface must be determined by the presence of small faults or fissures of later origin in the clays which underlie the city itself.

THE ANGLES OF CRYSTALS DURING GROWTH.—Miers has suggested that the formation of vicinal faces in crystals is due to the difference in the density of packing of the molecules in a crystal and those in a saturated solution. Further, it is considered that owing to the greater density of packing of the former the molecules of the solute separating from the solution find difficulty in compressing themselves into the closer packing of a simple crystal face. Experiments by E. S. Hedges described in the *Journal of the Chemical Society* for April 1926 support this view. By very slow growth of a crystal of sodium chlorate, single perfect cube faces have been obtained, since under such conditions the solute molecules can more easily take up their correct positions in the crystal face.

MAGNESIUM ELECTRODES IN SPECTRAL ANALYSIS.—The advantage of magnesium electrodes in cases where only small amounts of the material to be investigated are available are described by M. E. Dureuil in the *C. R. Acad. Sci.*, Paris, of April 26. Cylinders 1 cm. in diameter were employed as electrodes, the substance to be examined being placed in a cavity of about 1 mm. diameter in the positive electrode. They can be used either for arc or for spark spectra; in the former case the current should not exceed 1 ampere, to avoid ignition of the magnesium. The spectrum of magnesium is a simple one, with only about fifty lines, and in the region between 7000 and 3580 Å.U. there are only about ten strong lines; these do not come in the way of the characteristic lines of the other elements. Even with commercial magnesium the lines due to the impurities copper, iron, manganese, silicon, calcium, sodium, aluminium and carbon are weak, and would only cause difficulty in cases where these elements have to be investigated. The use of these electrodes has been found particularly valuable in the case of the platinum metals, the alkalis and alkaline earths, and especially for non-conducting minerals which resist the action of fused carbonates. This is probably due to the strong reducing action of magnesium, which at the high temperature of the arc or spark displaces the metals from their compounds, so that they give their dissociation spectra in the most favourable conditions.

THE ELECTRONIC STRUCTURE OF THE BENZENE MOLECULE.—In the *Journal of the American Chemical Society* for May 1926, L. Pauling discusses the electron-orbit-sharing theory of chemical bonds in connexion with the electronic structure of the benzene molecule. The carbon and hydrogen atoms are in the same plane at the corners of two concentric regular hexagons, and the manner in which they are connected by the shared bonds is described. Pauling extends this theory to naphthalene and anthracene, and shows that it accounts for the properties of these substances.

VITAMINS IN HEAT-STERILISED FOODS.—In view of the lack of direct evidence on the vitamin content of foods sterilised by heat and the conflicting results of earlier workers, C. M. Dugdale and R. J. Munroe have started a number of experiments on this subject. The first of the series, described in the *Journal of the Society of Chemical Industry* of May 21, deals with the presence of vitamins in meat preparations and shows, in the form of curves, the effects of various samples on the growth of rats reared on a vitamin-free diet. It is concluded that meat has a higher vitamin value than is usually supposed, and the heat processes used to sterilise it on a commercial scale affect the vitamins only slightly.

THE REACTION BETWEEN ETHYLENE AND CHLORINE.—Norrish studied the reaction between ethylene and bromine in a glass vessel and in glass vessels covered with wax, cetyl alcohol and stearic acid, and concluded that the reaction took place on the glass but not on the paraffined surface. Stewart and Edlund found that the reaction was of the second order, taking place entirely on the walls of the glass vessel containing the mixture. In the *Journal of the American Chemical Society* for May 1926, Stewart and Fowler describe the reaction between ethylene and chlorine in the presence of dry air. They state that this is also a second-order reaction taking place at the glass surface at approximately one-tenth of the speed the reaction between ethylene and bromine.

South-Eastern Union of Scientific Societies.

THE thirty-first annual Congress of the South-Eastern Union was held at Colchester on June 9-12, under the presidency of Mr. Reginald A. Smith, of the British Museum, in succession to Sir John Russell, director of the Rothamsted Experimental Station. In his address Mr. Smith dealt with "Essex in pre-Saxon Times," and pointed out that Essex is particularly rich in remains of the Early Iron Age, or Hallstadt period. Before the arrival of the Romans, Colchester was the capital of the most advanced of the British tribes. With the aid of the lantern, phases of pre-Saxon civilisation were illustrated. The gradual degradation of the British gold coin, founded on the Macedon stater, was shown, and the introduction of that on which there came to be shown an ear of corn, the origin of which still remains a mystery. A point of interest dealt with was the origin of the Red Hills, so called, although they are but raised platforms of burnt earth. The president's view was that they are the débris from the preparation of the ground for the construction of salt-works, the base of the pans with its growth of vegetation being burnt over, and the material then being scraped together and deposited in such a way as to form platforms, which may have been used as refuges by workers against sudden irruption of the tide. Workers were invited to inquire as to the finding of currency bars of iron, as at present none have been found in Essex.

Mr. Chas. E. Benham contributed a paper in which he dealt with "Colchester's greatest Citizen," Dr. William Gilbert, whose monumental work "De magnete," founded on actual experiment, laid the foundations of inductive science. He showed thus early that the earth is a magnet, and that the phenomena of the compass with its varying dip and declination all conform to that principle. Gilbert's terellæ and his other early instruments were bequeathed to the College of Surgeons, but they were all unfortunately destroyed in the great fire of 1666. The arms of the borough of Colchester constitute a story in themselves, and are associated with the legendary story of St. Helen. King Cole reigned at Colchester at the end of the third century, and was her father. He was the merry King Cole of the nursery rhyme. On his coming to terms with the Roman general Constantius, he gave the general his accomplished daughter Helena in marriage. The story is recorded in the ancient records of Colchester, which date from about 1350, so that historic accuracy cannot be claimed for it.

Dr. E. J. Salisbury's paper on "Plant Communities of the Seashore" was of special interest in view of the proximity of the town to wide stretches of estuarine flats, and an excursion to Mersea Island and the Strood enabled botanists to examine and collect specimens of the flora dealt with by Dr. Salisbury. The Strood is interesting as being a causeway of Roman foundation, connecting the island with the mainland. In the Pyefleet, running north from the Strood, are the chief oyster-beds belonging to the Colchester Corporation, and here as elsewhere constant warfare is being waged against the slipper-limpet, specimens of which were collected along the coast when a geological ramble was made to the cliffs at Walton-on-the-Naze. Tons of the slipper-limpet are annually dredged up by the corporation dredgers and destroyed, but the pest continues to increase.

No other town, said Dr. Mortimer Wheeler, possesses a local museum surpassing that of Colchester as a collection of Roman antiquities. He spoke in the great quadrangle of the castle, and described Camulodunum (Colchester) as the royal seat of the Trinobantes under the king Cunobelinus It was evident that the tribal community endeavoured to assimilate Roman culture and fashions It was the intention of the Romans to make Colchester the capital of Britain, an intention that was afterwards frustrated by geographical and other considerations. The Balkerne Gateway was the largest gateway erected by the Romans in Britain.

A paper by Mr. E. C. Stuart-Baker dealt with "Some Curious Aspects of Evolution" in bird-life and was illustrated by excellent lantern slides. Examples were given among the pheasants and other birds of the direct effect of environment on variations. One of the best-known and most widely accepted factors in evolution is the atmospheric condition of humidity. Excessive humidity acts upon the pelage or plumage and causes great darkness or brilliant colouring. A moderate amount of humidity generally results in a dull neutral tint, dark or pale in proportion to the amount of humidity being above or below normal. The absence of all humidity causes white or very pale coloration. The lecturer asked his audience to remember that when they were told that the various forms of pheasants shown can be produced in captivity by hybridisation, environment no longer exists in captivity, and man, by the selection of suitable individuals for the creation of the form which he desires to reproduce, takes upon himself the privileges and powers of environment.

Mr. Hazzledine Warren's paper on "The Correlation of the Lower Palæolithic" gave rise to considerable discussion, in view of the opinions which he expressed as to the age of Strepyan implements, and the distinctive characteristics and duration of Chellean and Acheulian cultures. In Mr. Edward A. Martin's paper on "Break-names in Geological History," he showed that while doubt exists as to the proper correlation for passage-beds, bone-beds and newly discovered strata, it would meet a want if names were allotted to the breaks between the recognised systems, to which such strata could be allocated at least tentatively. These names he proceeded to allot, all of which would be derived from the names of geologists, examples being 'Lapworthian' for the break between Ordivician and Silurian, and 'Whitakerian' for the break between Cretaceous and Eocene. These names would at once be recognisable from those of systems, since they are all personal names. In the discussion that followed, it was agreed that the subject deserved the attention of geologists.

In a paper by Mr. J. H. Owen, of Felsted, which was illustrated by very fine photographs by the author, the matter of the cuckoo and its foster-parents was dealt with in a masterly manner, and it was shown that the young cuckoo made use of its rump and tail rather than its back for the ejection of young birds and eggs from the nest. It would climb up backward the side of the nest, with the youngster on its back, and then by a final flick of its rump eject the unwanted one.

Regional survey subjects were dealt with by Mr. Alexander Farquharson on "The Social Constitution of a County"; by Mr. Geoffrey E. Hutchings on "The Choice of Maps for Regional Surveys."

In connexion with the Congress a volume has been published entitled "Essex: an Outline Scientific Survey," a concise statement of scientific research in the county, written by members of the Essex Field Club and others.

Mechanism of Oxidation in Living Tissues.

THE isolation of glutathione by F G. Hopkins in 1921 threw a fresh light on the processes of oxidation and reduction in living tissues, since the compound appeared to be of a simple constitution and not an enzyme, to which class of bodies the substances producing oxidation in the living organism were, in the majority of cases, considered to belong. Since then its constitution as a dipeptide of cysteine and glutaminic acid has been definitely proved, especially by its synthesis by Stewart and Tunnicliffe. It owes its activity in promoting oxidations to its property of acting either as a hydrogen donator, when it is present in the reduced (or cysteine) form, or as a hydrogen acceptor, when it is in the oxidised (or cystine) form: which form is present, depends on the conditions of its environment. Further details of its activity in promoting oxidations have recently been given by its original discoverer (F. G. Hopkins, *Biochem. Journ.*, 1925, vol. 19, p. 787). The paper deals with the oxidation of fats and proteins; at present the relationship, if any, between glutathione and carbohydrate utilisation has not been worked out.

Unsaturated fatty acids such as linoleic and linolenic are oxidised in the presence of the reduced form of glutathione (GSH), but the actual mechanism appears to be somewhat different at different hydrogen ion concentrations. At *p*H 3·0-4·0 large amounts of oxygen are taken up by the system: presumably a peroxide is formed by two thiol groups and the oxygen then passed on to the fatty acid, so that the reaction is catalysed by the GSH; it may be represented by the equation

$$AO_2 + 2B \longrightarrow A + 2BO,$$

where A = GSH and B = the fatty acid. On the other hand, at *p*H 7·4-7·6 less oxygen is taken up; in fact it is found that the amount is almost exactly twice that necessary to oxidise the GSH to the oxidised form (G_2S_2); in other words, the oxidation is a coupled reaction, according to the equation

$$AO_2 + B \longrightarrow AO + BO.$$

When the behaviour of the glycerides of the unsaturated fatty acids in the form of pure linseed oil was studied, different results were obtained. At *p*H 3·5-4·0 a latent period occurs before the oxygen uptake sets in; at *p*H 7·4-7·6 the equipartition of oxygen between GSH and the fatty acid is not seen, but after a high initial uptake the oxygen consumption falls off to a steady linear rate until nearly all the fat is oxidised. The point of inflexion on the curve corresponds to the time when nearly all the GSH has been oxidised, and unless there is a certain definite concentration of GSH present at the commencement, the oxidising system fails to become established. The cause of these variations is not yet known, but the establishment of the oxidising system in alkaline emulsions of linseed oil does not appear to be due to the presence of minute traces of iron.

For the investigation of the oxidation of the proteins the author has utilised certain pure preparations as well as a muscle powder obtained from the tissue by extraction with boiling water, and with alcohol and ether to remove lipoids, followed by drying and powdering. Such a muscle preparation in Ringer's solution at *p*H 7·6 and in the presence of oxidised glutathione (G_2S_2) takes up oxygen to the extent of 2000 c.mm. per gm. This oxidation occurs only in a solution of an alkaline reaction, and only when the protein is present as a solid phase, and also gives a positive nitroprusside reaction; that is, when it itself contains an -SH group. This 'fixed' -SH group of the protein is not oxidised by molecular oxygen, but can be by G_2S_2 even in the absence of oxygen. In this case the surrounding solution acquires a positive nitroprusside reaction owing to the reduction of the G_2S_2. The fixed -SH can be restored by contact with GSH; but it is not removed by simple washing of the tissue, nor is it a question of the adsorption of GSH to the tissue, but the fixed -SH appears itself to undergo alternate oxidation and reduction according to the conditions of its environment. It is probably the only reducing factor in the thermostable muscle residue.

It is to be noted that the amount of oxygen necessary to oxidise this fixed -SH group is only one-tenth of that taken up by the system in the presence of G_2S_2. Moreover, when the uptake of oxygen has ceased, restoration of the group by exposure of the powder to GSH will enable a further quantity of oxygen to be taken up with further oxidation of the protein: up to the present, an amount of oxygen equalling 10·0 c.c. per gm. of powder has been observed to be taken up, by renewing the fixed -SH group at intervals, and even this is not a maximum.

Pure proteins are not so active as the muscle powder. It is of interest to note that a protein which gives no nitroprusside reaction may be caused to react positively by denaturation. If GSH is added to the protein instead of G_2S_2, the initial oxygen uptake is quicker and the total oxygen uptake is greater by an amount which is nearly equal to that which would be required to oxidise all the GSH to G_2S_2; so that in both cases the oxidation of the protein proceeds with only minute amounts of -SH in solution.

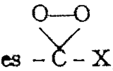
To sum up, the oxidation of fat and protein depends on the hydrogen-ion concentration of the solution and on the fact that GSH is oxidised quickly in an alkaline, but only slowly in an acid, medium. At *p*H 7·6 protein alone is oxidised, and since GSH is quickly oxidised to G_2S_2, the fixed -SH of the protein molecule must be intact to ensure the presence of -SH in the solution. At *p*H 6·0 both protein and fat are oxidised, the latter owing to the fact that the GSH is maintained at a higher concentration in the more acid solution. At *p*H 3·8 fat alone is oxidised; and the process is slower in the presence of G_2S_2, since its reduction to GSH is slow.

The question has been examined from a different point of view by J. H. Quastel (*Biochem. Journ.*, 1926, vol. 20, p. 166). Investigating the dehydrogenations produced by resting bacteria, he was struck by the great variety of substances which were capable of acting as donators or acceptors of hydrogen: moreover, closely related compounds behaved differently in the presence of *B. coli* and methylene blue; one might be oxidised and the other not. It seems scarcely possible that the organisms possess enzymes capable of acting on each different compound; on the other hand, there is good evidence that the change in the molecule of a compound which enables it to undergo oxidation or reduction takes place at the outer surface of each organism, though possibly in some cases at a surface in the interior of the cell.

Recent work has shown that molecules are orientated in a surface, so that it may be considered as a mosaic composed of the different molecules arranged singly or in groups in a definite pattern, which is characteristic for each cell, but varies slightly with its growth and activity. This molecular arrangement will lead to the existence of varying electric fields scattered over the surface of the cell, and the author considers that a molecule is 'activated,' and so becomes susceptible to oxidation (or reduction), when it comes under the influence of one of these electric fields, which causes a shift of electrons from one atom to another of the molecule. Thus the group $-CH=CH-$ becomes $-\check{C}-CH_2$. The movement of the proton will be determined both by the shift of the electrons and also by the electrical condition of the molecule itself. Thus if a radicle is one electron short of its full number it will, replacing an atom of hydrogen in the molecule, turn its positive end towards the carbon atom with which it combines, and so tend to repel a positive charge. The opposite effect occurs if the replacing radicle has one electron more than its full complement. $-OH$, $-NH_2$, and $-CH_2COOH$ repel positive electricity, whilst $-COOH$, $-CONH_2$, and $-COCH_3$ attract it. Thus on activation, $R-CH=CH-COOH$ becomes $R-\check{C}-CH_2-COOH$, and $R-CH=CH-CH_2-COOH$, $R-CH_2-\check{C}-CH_2-COOH$.

The theory therefore offers a possible explanation of the well-known β-oxidation of fatty acids in living animals. The author has examined a large number of compounds in the light of his theory and finds that his experimental results can all be explained by it. It offers a satisfactory reason why closely related compounds should differ in their behaviour as hydrogen donators in the presence of resting organisms, and obviates the necessity of postulating the existence of large numbers of enzymes which have never yet been extracted from these cells.

The author considers it probable that the $-SH$ group, as it exists in glutathione, is one of the means whereby oxygen is activated so that it becomes a hydrogen acceptor. In other cases this may be due to small traces of iron or to the development of a peroxide at an activated carbon atom; *e.g.* $-\check{C}-X$ becomes



$$-\overset{O-O}{C}-X,$$

so that the process which activates the hydrogen donator may result at the same time in the activation of oxygen

The Royal Society Conversazione.

THE Royal Society usually holds two conversaziones annually. The first of these gatherings was cancelled owing to the general strike, and the second was held on June 16 last. Many of the exhibits arranged in the Society's rooms have already been referred to in our columns. Limitations of space forbid more than passing notice of some of the remainder.

The Department of Entomology, British Museum (Natural History) (Mr. F. W. Edwards and Dr. P. A. Buxton) exhibited specimens of a submarine Chironomid. This is the first insect species known to spend its whole life in the sea, and was discovered by Dr. P. A. Buxton in Samoa, where it was found associated with other Chironomid flies having normal air-living adults. Mr. T. S. P. Strangeways and Dr. H. B. Fell showed microscope preparation of the development *in vitro* of the isolated eye of the embryonic fowl. Fowl embryos of 64-70 hours' incubation were used. An eye is dissected out and explanted into a medium composed of fowl plasma and embryonic tissue extract; here it grows and differentiates in a surprisingly normal way.

The Soil Physics Department, Rothamsted Experimental Station (Dr. B. A. Keen and Dr. W. B. Haines), exhibited a new combination of apparatus for measuring soil resistance, which has marked advantages over the usual type of dynamometer. It is light and portable, and gives a continuous record of the draught, and a time scale, on a celluloid strip, which has great advantages over paper for outdoor work under varied weather conditions.

Lieut.-Col. F. J. M. Stratton and Mr. C. R. Davidson showed a number of photographs of the solar eclipse of January 14 last, taken at the expedition sent to Benkulen, Sumatra. The expedition obtained good photographs of the corona, the spectrum of the chromosphere, and also of the corona both with slit spectroscope and prismatic cameras, from a discussion of which it is hoped that fresh knowledge may be gathered as to the condition and constitution of the solar atmosphere. From the spectrograms of the corona it will be possible to obtain accurate wave-length measurements of the lines of the coronal spectrum of unknown origin.

Prof. O. W. Richardson showed an apparatus for the investigation of soft X-rays which are produced by the electronic bombardment of solids. The tube is of transparent silica, and is exhausted to a pressure of about one ten-millionth of a millimetre of mercury. The presence of the X-radiation is demonstrated by the photoelectric emission which it produces from a copper-plate enclosed in the tube.

The National Physical Laboratory had two interesting exhibits. The vector colorimeter (Mr. Guild and Dr. Perfect) enables a colour to be specified by *qualitative* measurements involving colour matches only. Two colour matches are made. In one the test colour is matched by a mixture of spectrum red with monochromatic light of suitable wave-length; in the other by a mixture of spectrum blue with another suitable monochromatic constituent. These matches determine the two vectors, and their intersection determined the position of the colour on the colour chart. A modified manometer for the determination of the vapour tensions of molten cadmium and zinc was also shown (Mr. C. H. M. Jenkins). This is measured by the pressure of nitrogen required to level the two liquid surfaces of the metal of a specially shaped manometer. The closed end of the manometer can be flooded by rotation of the apparatus, and foreign gases can also be removed by a similar rotation accompanied by a reduction of pressure.

Mr. W. M. Mordey showed some experiments demonstrating the possibility of getting a powerful rotation, in multiphase alternate current fields, of magnetic materials which are either non-conducting in themselves or are made so by being reduced to fine powder and then made up into solid discs or cylinders with some binding material, such as glue or shellac, which insulates the particles from one another. Such discs or cylinders, which form miniature induction rotors without windings and with non-conducting cores, can be made up of powdered magnetic materials such as hard cast-iron dust, hard steel grit, nickel, cobalt, and of the magnetic minerals magnetite and pyrrhotite; in such bodies no appreciable eddy currents are produced, the rotation being due entirely to hysteresis. An interesting item in the exhibit was a small alternate-current electric fan, the rotor of which consisted simply of a piece of pyrrhotite rock with no winding on it, revolving freely in the field of a small model multiphase magnet. Loose powders of any of these materials rotated in such multiphase fields in a direction opposite to that in which solid masses of the same materials rotate, a reversal of direction due to a rolling action of the particles. No eddy currents are induced in any of the conducting materials when powdered. Dr. W. H. Eccles and Dr. Winifred Leyshon showed a neon tube and tuning fork combination for producing electrical oscillations of harmonic frequencies suitable for calibrating wave-meters. The neon tube is connected in parallel with a condenser and in series with a resistance and a battery; it then gives an intermittent luminous discharge and the current can be used to keep a steel tuning-fork in continuous vibration. The current in such a circuit has many high harmonics, and therefore induces an oscillatory current of any chosen harmonic frequency in a neighbouring circuit tuned to that frequency.

Sir Robert Hadfield, Bart., exhibited a number of specimens of alloy steels for special purposes. These included a rotor in 'ERA/ATV' steel used in the construction of exhaust gas turbines. These rotors are driven by the exhaust gases from internal combustion engines; they work continuously at a temperature of from about 800° to 950° C., and run up to the very high testing speed of 53,000 revolutions and working speeds of about 30,000 revolutions per minute. A tuning-fork of high nickel-chromium alloy steel was shown which has constant frequency under varying temperature. For this purpose the metal must have a very low temperature coefficient of the modulus of elasticity.

University and Educational Intelligence.

Birmingham.—The new buildings for the Department of Oil Engineering and Refining (which have been in use during the past session) were formally opened on June 19 by Sir John Cadman. The department is remarkably well equipped for the training of students in the science and practice of oil technology. There is special provision for experimental research in the production of synthetic liquid fuels and for high-pressure work on the Bergius process. There is a three-year course leading to the ordinary B.Sc. degree and a four-year course for an honours degree in the subject. There is in addition a post-graduate school open to honours graduates of approved universities who have taken engineering or chemistry as principal subjects.

Cambridge.—The late Mr. W. W. Rouse Ball, Trinity College, who died on April 4 of last year, has left to the University a sum of 25,000*l.* on condition that a professorship or readership of or directly connected with mathematics should be founded, and a further 25,000*l.* for a professorship or readership of some branch or branches of modern English law. He expressed a hope that these professors or readers should include in their lectures historical and philosophical aspects of their subjects. He further left a sum of 10,000*l.* the income from which is to be used for the benefit of, or toward the expense of maintaining, the University library.

In connexion with the celebration of the Bacon tercentenary by Trinity College in October next, it is proposed to confer the honorary degrees of LL.D. on Prof. W. S. Holdsworth, of the University of Oxford, and of Sc.D. on Sir Ernest Rutherford, Trinity College, Cavendish professor of experimental physics and president of the Royal Society.

It is announced from Magdalene College that elections to the Donaldson and Charles Kingsley Bye-Fellowships for the encouragement of research will be made early in July, applications to be made to the Master, Magdalene Lodge, before June 30.

Edinburgh.—The bicentenary of the institution of the Faculty of Medicine was celebrated on June 10 and 11, when representatives of many famous schools of medicine at home and abroad took part in the commemoration. At the special graduation ceremonial the honorary degree of LL.D. was conferred on the following alumni of Edinburgh: Dr. Andrew Balfour, Director of the London School of Hygiene and Tropical Medicine; Prof. Robert Howden, professor of anatomy, University of Durham; Prof. W. T. A. Jolly, professor of physiology, University of Cape Town; Sir George Newman, Ministry of Health; Prof. Alexander Primrose, professor of clinical medicine, University of Toronto; Sir John Robertson, professor of public health, University of Birmingham; Prof. Ralph Stockman, professor of materia medica, University of Glasgow; Dr. A. Logan Turner, president of the Royal College of Surgeons, Edinburgh; Sir Norman Walker, treasurer of the Royal College of Physicians, Edinburgh; Prof. J. T. Wilson, professor of anatomy, University of Cambridge.

After the graduation Sir George Newman gave an address in which, beginning with the primitive school of medicine at Salerno and later considering the schools in Bologna, Padua and Leyden, he traced the influences which led to the founding of the Edinburgh School. He emphasised the great influence exerted by Boerhaave upon Alexander Monro, who was the founder of the Medical Faculty in Edinburgh, and upon John Rutherford, who introduced clinical teaching in Edinburgh upon the Leyden model. This bedside teaching, with its subsequent developments of clerking and dressing, became one of the characteristic features of the Edinburgh School, which has been copied all over the world. Sir George referred to some of the discoveries associated with the Edinburgh School and remarked that, like all discoveries, they were but stages in the pursuit of truth—they did not begin nor were they completed in Edinburgh, but all of them were substantially advanced there, and of two of them—Simpson's work on the anaesthetic action of chloroform and Lister's antiseptic surgery—it might be said they had entered into the history of mankind.

The reconstructed Surgery Department was formally opened by Sir John Gilmour, Secretary for Scotland. The cost of the reconstruction has been largely met by a generous gift from Mr. T. S. Thomson, brother of the late professor of surgery, Alexis Thomson.

At the meeting of the University Court on June 14, intimation was received from Dr. Harold Robinson, reader in natural philosophy, of his intention to resign, as from the end of the academic year, on his appointment to the chair of physics in the University College of South Wales and Monmouth, Cardiff.

Leeds.—Mr. B. A. McSwiney has been elected to the chair of physiology, vacant through the death of Prof. W. F. Shanks. Mr. McSwiney is a graduate of the University of Dublin in arts and medicine, and after the War was appointed assistant professor of physiology at Trinity College, Dublin. In 1919 he became lecturer in experimental physiology at Leeds and in the following year at Manchester, a position which he still occupies. He is secretary of the Section of Physiology of the British Association.

Dr. Richard Douglas Passey has been elected to a new chair of experimental pathology and as director of cancer research. Dr. Passey, who is at present lecturer in pathology in the Welsh National School of Medicine, Cardiff, has been engaged in cancer research for some years past, and has published a number of papers on the subject.

Contemporary Birthdays.

June 25, 1859.	Prof. Sydney John Hickson, F R.S.
June 26, 1869.	Sir John Flett, K.B E, F.R S
June 27, 1855.	Admiral Sir A. Mostyn Field, K.C.B., F.R S.
June 28, 1851.	Sir Alfred Hopkinson, K C, M P
June 29, 1868.	Dr. George Ellery Hale, For. Mem. R.S
June 29, 1844.	Sir Francis Fox, M. Inst. C.E
July 1, 1840.	Mr. Edward Clodd

PROF. HICKSON is a Londoner. He was educated at University College School, and Downing College, Cambridge. In his early career he was some time assistant to Prof. H. N Moseley, at Oxford. Since 1894 Prof. Hickson has occupied the chair of zoology in the Victoria University, Manchester.

Sir JOHN FLETT, director of H.M. Geological Survey since 1920, was born at Kirkwall, Orkney. He was educated at Watson's College, and at the University of Edinburgh, coming there under the guidance, in geological work, of Prof. James Geikie. Before his present official post he was assistant to the director of the Geological Survey of Scotland In 1902, jointly with the late Dr. Tempest Anderson, he investigated, at the desire of the Royal Society, the volcanic eruption of the Soufrière, in St. Vincent, West Indies, publishing a voluminous report in the *Philosophical Transactions*. Sir John was awarded the Bigsby medal of the Geological Society in 1909.

Sir MOSTYN FIELD, who has carried out highly important marine survey work, was hydrographer to the Admiralty from 1904 until 1909.

Sir ALFRED HOPKINSON, who was born in Manchester, was educated at Owens College in that city, and at Lincoln College, Oxford Principal of Owens College from 1898 until 1904, he was vice-chancellor of Victoria University of Manchester in 1900–13. Sir Alfred is member of Parliament for the combined English Universities. He is Hon. LL.D. of Glasgow and Aberdeen.

Dr. HALE, distinguished for his researches in solar and stellar spectroscopy, and joint editor of the *Astrophysical Journal*, was born at Chicago. Organiser, and then director of the Yerkes Observatory of the University of Chicago, from 1895 until 1905, he afterwards took up the directorship of Mount Wilson Observatory, Pasadena, California. In 1904 the Royal Astronomical Society awarded its Gold Medal to Dr. Hale for his spectroheliograph method of photographing the solar surface and other astronomical work.

Sir FRANCIS FOX, whose father was Sir Charles Fox, the distinguished engineer of early Victorian times, was born in London. One of the engineers of the Mersey Tunnel, Sir Francis, jointly with his brother, the late Sir Douglas Fox, were constructors of two underground railways. The development of railway schemes in South Africa also engaged his attention. Sir Francis has given unstinted assistance to the authorities of various English cathedrals concerning subsidence problems.

Mr. CLODD was born at Margate and educated at Aldeburgh Grammar School. It means and expresses much to say that he was among those in Huxley's circle of intimates in "the Marlborough Place days." Fifty-four years ago Mr. Clodd published "The Childhood of the World," the precursor of many studies concerning evolutionary foundations.

Societies and Academies.

LONDON.

Royal Society, June 17.—Sir Arthur **Schuster**: A review of Mr. George W. Walker's magnetic survey (1915). Recent magnetic surveys seem to show that the components of magnetic force cannot be completely represented by a potential function, but indicate electric currents cutting the surface of the earth with current densities that are far greater than those obtained from direct measurement. Examination of Mr. Walker's magnetic survey suggests the careful examination of a comparatively small area, rather than an extensive survey of districts so large as those into which the country was divided by Walker in order to test the reality of these currents. If observations are taken at four stations, two of which lie in the meridian and two on a circle of latitude, each station being at a distance of 1·8 miles from the central point, the density of the earth-air current may be determined with a probable error of 0·1 ampere per square kilometre, on the assumption that the difference between the magnetic components at two of the stations can be determined with a probable error of 3γ in a single comparison, and that the observations are repeated 25 times The mean current density derived from Mr. Walker's survey of eight separate districts is 0·24 Lord **Rayleigh** The continuous spectrum of mercury vapour in relation to the resonance line 2536·52. The continuous spectrum can be produced without the resonance line, by fluorescent excitation with the aluminium spark, as originally observed by Wood. Under these conditions the continuous spectrum ends at 2535·9 Å.U. and the resonance line appears dark on the continuous background. The band at 2540 also appears sharply reversed on this background. The same continuous spectrum can be obtained in absorption. In this case the measured limit was 2535·5 By lowering the density of the vapour the spectrum with aluminium spark excitation is completely reversed, the resonance line 2536 52 Å U. and the band 2540 Å U now appearing bright on a comparatively dark background. The same effect is obtained by electric discharge in fairly dense vapour, if the exposure is not too heavy —O W. **Richardson**: Structure in the secondary hydrogen spectrum (iv.). A more detailed examination of the spectrum has shown that there are a number of other lines which belong to the same system as Fulcher's bands. It is proposed to rearrange these lines so that S_3 to S_{-1} form a Q branch, S the first line of an associated R branch to which there is a corresponding P branch, S_6 and S_{-2} the first two lines of an associated Q' branch, and S_7 the first line of an associated R' branch to which there is a corresponding P branch. This holds throughout the first five of the six red bands. Four similar bands occur in the green and five in the blue; but the branches in those regions which would correspond to the dashed letters have not yet been located with certainty. There is a combination such that $R(m) - P(m+1)$ has the same value for corresponding lines of corresponding bands in the red, the green, and the blue The quantum structure of the bands can be represented by terms of integral and semi-integral type. The emitter of this band system is the neutral hydrogen molecule H_2 formed and excited by the combination of the ionised hydrogen molecule H_2^+ with an electron.—W. L. **Bragg** and J. **West**: The structure of beryl, $Be_3Al_2Si_6O_{18}$. Beryl has the composition of a metasilicate, the ratio of silicon to oxygen atoms being one to three, though silicon is surrounded everywhere by four oxygen atoms arranged tetrahedrally, resembling the arrangement in orthosilicates, such as olivine, monticellite, and garnet. The group SiO_4 shares an oxygen atom with each of two neighbouring groups, thus attaining the correct ratio of silicon to oxygen. The hexagonal beryl has a structure like a honeycomb, hexagonal axes passing down empty channels at the centres of cells, the walls of which are formed of densely packed oxygen atoms grouped around beryllium, aluminium, and silicon atoms No atomic centre is closer than 2·55 Å U. to a hexagonal axis The analysis of the structure, which has seven parameters, is carried out by quantitative measurements of intensity of reflexion —**A P. Laurie**. On the change of refractive index of linseed oil in the process of drying and its effect on the deterioration of oil paintings. The tendency of the modern oil picture to lower in tone is partly due to the yellowing of the oil film and partly to changes in refractive index The inquiry took two directions; (1) The examination of certain pigments by grinding them in liquids of various refractive indices, higher than linseed oil, noticing the change of tone and examining under a microscope so as to classify them in order of translucency. (2) In order to test change of refractive index, an oil film was painted out on the glass of a Smith refractometer and observed from time to time During drying the index rose from 1·480 to 1·490. Since then the film has been observed for some eight or nine months, and the index is now greater than 1·500, a change which produces a visible effect on white-lead and pale yellows. This slow change of refractive index no doubt continues for many years Light is thus thrown on the method of painting in oil by the fifteenth-century painter, who laid down a scheme in black-and-white or brilliant colour in a medium of low refractive index, and glazed over this with thin oil paint, thus securing that as the pigments became more translucent more light would be reflected from the painting below, thereby keeping up tone and brilliancy in his pictures

Royal Microscopical Society, May 19.—**James C. Mottram** A note on the effects of β-radiation on *Colpidium colpoda* as seen in stained specimens In view of the presence of macro- and micro-nuclei in Infusoria, and of the different functions which these appear to control, the macro-nucleus controlling asexual cell division, and the micro-nucleus syngamy and sexual division, exposures to radium were made to discover whether the nuclei would exhibit any differences in sensitiveness to β-radiation No histological changes were observed in the micro-nucleus. The macro-nucleus, however, was affected by relatively short exposures. Stained specimens also showed another early effect In this species, rod-shaped mitochondria lying close to the surface are arranged in lines running longitudinally; after irradiation, the microchondria are distributed at random, and instead of being rod-shaped, and of approximately the same size, they are seen to be irregular granules of various sizes.—**Miss Joyce F. Raves**: Mitosis in *Anacylus Pyrethrum* The chromosome number is 18, a number in accordance with the chromosome number series of the Anthemideæ, the cardinal number of this series being 9 In the prophase stages of nuclear division there is observed a parallel banding of the spireme, similar to that seen in telophase, and the following division always occurs at right angles to the direction of this banding There is some evidence that when one daughter nucleus is to divide in a plane at right angles to that of the former division, it revolves through a right angle while in the telophase condition, before it is completely rounded off as a new nucleus, so that the next division may also be at right angles to the direction of the spireme banding. This suggests that the nuclear material never changes its position during the resting stage.

EDINBURGH.

Royal Society, June 7.—**F H Edgeworth**: The development of the cranial muscles of Protopterus and Lepidosiren The main facts in the development of the mandibular skeleton as described by Agar are confirmed, but a separate ascending process of the pterygoquadrate, with typical relations to the first division of the fifth nerve, is described The cranial muscles of the Dipneumona are very similar to those of Ceratodus. They are more primitive in that external gill-muscles are present In other respects they are similar to, or show slight modifications of, those present in Ceratodus.—**G. W. Tyrrell** and **M. A. Peacock**: The petrology of Iceland; Part I, The basic tuffs, by **M. A. Peacock** The Pleistocene basic tuffs of Iceland are either sideromelan-tuffs or palagonite-tuffs. Sideromelan is basaltic glass which is produced in the fragmented condition by subglacial extrusions; the drastic chilling thus suffered by the extruded liquid renders the product translucent, due to the inhibition of ore-separation Palagonite is the hydro-gel of sideromelan. Palagonitisation results from the action on sideromelan either of hot springs, or of cold sea-water.—**E. Prawochenski** and **B. Kaczkowski**: Observations on the fragment of a horse skull from interglacial deposits near Pulawy, Poland. The Vistula horse belonged to the group of small European horses, probably to the Tarpans (Gmelin), or to the ponies of the "plateau type" (Ewart)—the group which included Celtic and Arab ponies, characterised by slender limbs, and only two of the eight callosities found in horses of the forest type. The Veglia (Adriatic) pony, though hitherto regarded as descended from the Tarpan, really belonged to a forest type. The wild horse (*E. przewalskii*) of Mongolia belonged to "the heaviest type of the primitive equidæ"—an interesting conclusion, because some authors who studied the skulls of modern heavy breeds, came to the conclusion that in all probability the Clydesdales and Shires included steppe horses among their ancestors —**J Cossar Ewart**: The coat of the Lapland wolf In some mammals the coat consists almost entirely of simple fibres made up of a solid cortex and of a cuticle, *i.e.* of wool fibres; in others the coat consists of fibres containing pith cells separated by spaces, thus forming a discontinuous pith or medulla, *i e.* fur fibres; in other mammals there is a continuous medulla, and these are known as true hair fibres. In the wolf the coat consists of bundles of fur fibres, all the fibres of each bundle occupying a single pit or follicle. In the Lapland wolf there are long coarse fibres, forming an outer coat, and fine and intermediate fibres forming an inner coat The inner portion of the long fibres has the structure of fur, the outer portion has the structure of true hair, the middle portion differs but little from fur proximally but resembles hair distally. The short fine fibres of the inner coat are typical fur fibres The inner portion of the intermediate fibres has a discontinuous medulla, the outer portion a continuous medulla as in the long outer coat fibres. Instead of all the fibres of a bundle occupying one pit or follicle, the root of each fibre is lodged in a separate follicle, there is a large follicle for the long outer coat fibre, and underlying the large follicle fifteen or more slender follicles for the fine and intermediate fibres of the inner coat. In some dogs there are, in addition to wool fibres and fur fibres, numerous fibres the inner half of which has the structure of wool, the outer of true hair. Sometimes the inner third resembles wool, the middle third fur, and the outer third true hair.—**Y. Tamura** and **F. A. E. Crew**. The effect of uncomplicated vasectomy and epididymo-differentectomy in the mouse. Definite degeneration of the germinal epithelium is induced by both procedures, but its onset and progress are much more rapid after epididymo-deferentectomy.

PARIS.

Academy of Sciences, May 17.—**André Blondel**: The initial conditions of the disturbed régime of currents.—**R. de Forcrand**: The thermochemistry of thallium alcoholates and salts.—**M. Biernacki**: Some theorems of algebra.—**Leonida Tonelli**: The quadrature of surfaces.—**Gaston Julia**: The polynomials of Tchebichef.—**W. S. Fédoroff**: The representation of analytical domains and functions.—**Stefan Kempisty**: The differentials of the ensemble function.—**J. L. Routin**: A new synchronous induction motor starting automatically, and capable of being worked by Hertzian waves, with reference to the problems of teleindication and television.—**C. G. Bedreag**: The arc spectrum of copper.—**F. Darmois**: The salt effect and rotatory power.—**A. Zimmern** and **Maxime Coutin**: The production of polarising surfaces by the deposit of herepathite upon vertical plates.—**Pierre Auger**: The yield of fluorescence in the domain of the X-rays.—**René Dubrisay**: Researches on adsorption.—**P. Brun**: The properties of ternary liquid mixtures. Studies of the physical properties of mixtures of water and ethyl alcohol with a third alcohol. For the third alcohol the three cases studied were propanol, entirely miscible, isobutanol, fairly miscible, and isoamyl alcohol, slightly miscible. Curves are given for the case of isoamyl alcohol.—**B. Bogitch**: Concerning the granulation of scoria and of metals. The usual method of pouring into water from a height occasionally gives rise to explosions. If compressed air is forced into the bottom of the water vessel, below the point of fall of the liquid jet, the risk of explosion is removed. The dimensions of the water vessel can be reduced, and a smaller height of fall for the liquid jet is possible.—**N. Bezssonoff**: The rapid preparation of mono-molybdophosphotungstic acid, a reagent for polyphenols and vitamins. The purification is based on the insolubility of the complex acid in 30 per cent sulphuric acid.—**J. Bougault**: An example of a hydrated ketone ether oxide. A correction of some results given in earlier communications.—**Mme. Pauline Ramart**: The alkylation of the nitriles of the fatty series. The preparation of di- and trialkylacetonitriles. Aliphatic nitriles, treated with sodium amide, give sodium derivatives, and these when treated with alkyl halogenides give the α-alkylnitriles.—**R. Marquis**: The oxidation of acenaphthene. Acenaphthene can be directly oxidised to acenaphthenol by lead dioxide in acetic acid solution.—**J. H. Hoffet**: The age of the limestones of Crete.—**P. L. Mercanton**: The magnetisation of Australian volcanic rocks. From the magnetisation of the rocks examined it is concluded that the inclination of the earth's magnetic field in Australia was at one time in the opposite sense to that at the present day.—**Lucien Mayet**: A summary anthropological examination of the fossil men of Denise, near Le Puy-en-Velay. These remains represent the oldest human documents discovered in France, coming between *Eoanthropus Dawsoni* and *Homo neanderthalensis*.—**F. Roman**: The discovery of a fauna of mammals of the Pontian stage at Libros (Province of Teruel, Spain).—**A. Demolon**: The absorption and mobilisation of the potassium ion in clay colloids.—**Edmond Sergent** and **H. Rougebief**: The antagonism between drosophils and moulds.—**Claude Fromageot**: The oxidation-reduction potential of reversible oxidising systems, and the oxidation of organic molecules by these systems.—**H. Barthélemy**: The action of glycogen and of white of egg of the fowl on the spermatozoids of *Rana fusca*.—**Robert Weill**: A special category of nematocysts common to hydra, gymnoblastids and siphonophores.—**Ch. Porcher**: The action of heat on the complex caseinate of lime plus calcium phosphate. The greater sensibility of the phosphatic particles.—**Georges Bourguignon**, **Max Courland** and **Mlle. Renée Déjean**: Variations of chronaxy in lesions of the retina and of the retro-bulbar segment of the optic nerve.

ROME.

Royal National Academy of the Lincei, April 11.—**Leonida Tonelli**: Quadrature of surfaces.—**G. A. Crocco**: The possibility of super-aviation. Although it may be possible by the ordinary means of aviation to attain sub-acoustic velocities, hyper-acoustic velocities would require a new moto-propulsive method such as that of the reaction propulsor. In such a case, if the weight remains constant, the quantity of fuel necessary for a certain horizontal, uniform flight is inversely proportional to the product of the velocity of flight and the velocity of egress of the propulsive jet.—**A. Angeli**: Supposed priority with regard to the conductivity of unsaturated chains.—**Antonio Colucci**: An assumed property of symmetrical determinants of the sixth order.—**Luigi Fantappiè**: Determination of groups with a parameter of linear functionals.—**Guérard des Lauriers**: Spaces geodetically applicable beyond Dini's case.—**Gaetano Scorza**: Apiristic resolution of binomial congruences and Lagrange's interpolation formula.—**E. Bompiani**: The geometry of surfaces considered in ruled space.—**Mauro Picone**: The duration of small oscillations of the most general curvilinear pendulum.—**Vasco Ronchi**: Zonal gratings as interferometer objectives.—**Luigi Rolla** and **Giorgio Piccardi**: Ionisation potentials of certain elements of the rare earth group.—**Giorgio Piccardi**: The affinity of the iodine atom for the electron.—**Giulia Lugaro**: Bismuthinite from St. Agnes (Cornwall).—**F. Stella Starrabba**: Two different diagrams for the eruptivity of Japanese volcanoes.

VIENNA

Academy of Sciences, May 6.—**L. Moser** and **K. Schmidt**: Determination and separation of rare metals from other metals (vii). Determination of tungsten compounds and of metallic tungsten by distillation in a current of carbon tetrachloride vapour. The addition of chlorine to the tetrachloride checks dissociation and reduces the concentration of nascent chlorine. By the addition of air, carbon is oxidised and more nascent chlorine liberated. Tungsten, tungstates, tungsten minerals were completely decomposed and tungsten chlorides obtained in the distillate, and either precipitated with benzidin or evaporated to dryness with nitric acid. Since iron is also volatilised, a method was worked out for heating an iron-tungsten mixture with ammonium bromide at 300°, which volatilised iron only. Tungsten wire has proved very resistant to chemical attack. It was oxidised in an oven by oxygen to WO_3, and even this oxide was resistant in carbon tetrachloride. The WO_3 was reduced by hydrogen to amorphous tungsten, which could easily be volatilised in carbon tetrachloride. Various oxides remain behind. This quick method of analysing tungsten wire is likely to be useful in the incandescent lamp industry.—P. T. **Schwarz**: Influence of thermometer exposure on the observed results of temperature in Kremsmunster.—H. V. **Ficker**: Direction of wind and clouds in Teneriffe.—F. **Kerner-Marilaun**. Harmonic analysis of the temperature in the South Atlantic current circuit. Diagrams were drawn on the Seewarte-Atlas dividing the main line of the current into 24 equal portions. The points of this division were transferred to the isotherm chart. Diagrams were drawn for the yearly warmth transition at each point, and hence equations were obtained.—F. **Werner**: New or little-known snakes in the State Museum of Natural History at Vienna.—L **Hajek** and F. **Scheminzky**: Low-frequency amplifiers in phonograph construction.—G. **Luft**: Distribution of saponins and tannins in plants.—P. **Fantl** and M. **Kabos**: Zinc-dust distillation of cholesterin.

Official Publications Received.

Review of Agricultural Operations in India, 1924–25 Pp vi+162+10 plates (Calcutta. Government of India Central Publication Branch) 2.2 rupees; 4s.

Wisconsin Geological and Natural History Survey Bulletin No. 56 A, Soil Series No. 28. Soil Survey of Milwaukee County, Wisconsin, by A. R Whitson, W. J. Geib, and T. J Dunnewald; Bulletin No. 56 B, Soil Series No. 59: Soil Survey of Racine and Kenosha Counties, Wisconsin, by A R Whitson, W. J Geib, H. W. Stewart, W M. Gibbs and C. B Clevenger, Bulletin No. 56 C, Soil Series No 60. Soil Survey of Walworth County, Wisconsin, by A. R Whitson, W. J Geib, W H. Pierre and C. B Clevenger Pp 68+2 plates+94+4 plates+98+8 plates+8 maps. (Madison, Wis)

Proceedings of the Royal Irish Academy Vol 37, Section A, No 3: The Breaking of Water-drops by Electric Fields By Prof J J. Nolan Pp 28-39 1s Vol 37, Section B, Nos. 10, 11, 12 The Action of Nitric Acid and of Nitrogen Peroxide on Triphenylamine, by Dr Hugh Ryan and Amy Markey, The Relative Speeds of the Removal of Nitric Acid from Systems containing certain Aromatic Compounds, by Dr. Hugh Ryan and Mary Glynn; The Action of the Oxides and the Oxyacids of Nitrogen on β-Dinaphthylene Oxide, by Dr. Hugh Ryan, Donal Flood and Patrick M'Nulty Pp. 71-89 1s. Vol 37, Section B, No. 13: The Swamp Cypresses, Glyptostrobus of China and Taxodium of America, with Notes on allied Genera. By Augustine Henry and Marion McIntyre Pp. 90-116+8 plates. 1s. 6d (Dublin: Hodges, Figgis and Co.; London Williams and Norgate, Ltd)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol 14, Part 4: Comparative Studies on the Physiology of *Fusarium Lini* and *Colletotrichum Lini* By Yoshihiko Tochinai. Pp 171-236. (Sapporo)

The Institute of Brewing Research Scheme. Report 5 Being a Report of the Research Work of the Institute from April 10th, 1924, to April 30th, 1926 Pp 16 (London Brewers' Hall, Addle Street, E C.2)

Treasury Department: United States Coast Guard Bulletin No. 14. A Practical Method for Determining Ocean Currents. By Lt.-Comdr Edward H. Smith. Pp vi+50. (Washington, D C. Government Printing Office)

Sudan Government. Wellcome Tropical Research Laboratories, Khartoum Report of the Government Chemist for the Year 1925. (Chemical Section, Publication No 30.) Pp. iii+29 Report of a Meeting in the Sudan Gezira in December 1925 for the Discussion of certain Problems connected with Cotton Growing Pp. 38 (Khartoum.)

Experimental and Research Station, Nursery and Market Garden Industries' Development Society, Limited, Turner's Hill, Cheshunt, Herts. Eleventh Annual Report, 1925 Pp 143 (Cheshunt, Herts.)

Records of the Botanical Survey of India. Vol. 11, No 1 (i) List of Species and Genera of Indian Phanerogams not included in Sir J D Hooker's "Flora of British India," by C. C Calder, V Narayanaswami, and M S Ramaswami, (ii) Loranthaceae of Southern India and their Host Plants, by C E. C Fischer. Pp. iv+195+4 plates. (Calcutta Government of India Central Publication Branch) 3 rupees, 5s 3d.

The Carnegie Foundation for the Advancement of Teaching. Twentieth Annual Report of the President and of the Treasurer. Pp vi+241. (New York City.)

Transactions of the Astronomical Observatory of Yale University Vol 5. Catalogue of 5833 Stars, -2° to +1°. By Frank Schlesinger, with the collaboration of C. J. Hudson, Louise Jenkins and Ida Barney Pp. vi+83+120 (New Haven, Conn)

University of California Publications in American Archaeology and Ethnology. Vol. 18, No 3. Miwok Cults. By Edward Winslow Gifford Pp 391-408 25 cents Vol 23, No 1: Archaeology of the Southern San Joaquin Valley, California. By E. W. Gifford and W. Egbert Schenck Pp 122+34 plates. 1 50 dollars. (Berkeley, Calif.: University of California Press; London. Cambridge University Press)

The Journal of the Royal Agricultural Society of England Vol 86 Pp. 8+301+clxxiv (London: John Murray) 10s.

Department of Commerce: Bureau of Standards Miscellaneous Publication of the Bureau of Standards, No. 72: Strain Lines developed by Compressive Tests on Structural Members of the Delaware River Bridge at the United States Bureau of Standards for the Delaware River Bridge Joint Commission. Chart, 18 in × 15 in. (Washington, D C.: Government Printing Office.) 5 cents.

University of Illinois Engineering Experiment Station. Bulletin No. 154. An Investigation of the Translucency of Porcelains. By Prof Cullen W. Parmelee and Pierce W. Ketchum. Pp 26. (Urbana, Ill.) 15 cents.

Aeronautical Research Committee, Reports and Memoranda, No 978 (Ae. 192) Measurement of the Rotary Derivative *Mq* on the 1/5th Scale Model Bristol Fighter in the Duplex Wind Tunnel By E. F. Relf (A 2 a. Stability Calculations and Model Experiments, 96—T. 2081) Pp. 15+11 plates. 1s. net. Reports and Memoranda, No 996 (Ae. 204): On the necessary Size of Aerodromes in order that a Landing may be made if the Engine fails when getting Off. By H Glauert. (D 1 Special Technical Questions 146—T. 2183) Pp. 10+3 plates 6d net. (London. H.M. Stationery Office)

Agricultural Census of the Colony and Protectorate of Kenya. Sixth Annual Report, 1925. Pp. 44 (Nairobi: Department of Agriculture.)

Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, read at the Annual Visitation of the Royal Observatory, 1926, June 5. Pp 18 (London: Royal Observatory, Greenwich)

Ministry of Public Works, Egypt. Report on the Work of the Physical Department for the Year ending March 31, 1924. By Dr. H E Hurst. Pp 20 (Cairo: Government Publications Office.) 5 P T.

Survey of India. General Report 1924 to 1925, from 1st October 1924 to 30th September 1925 Published by Order of Col Comdt E. A. Tandy Pp viii+45+iii (Calcutta: Survey of India) 1 rupee; 1s. 9d.

Bulletin of the American Museum of Natural History. Vol. 53, Art. 1. The Macruran, Anomuran and Stomatopod Crustaceans collected by the American Museum Congo Expedition, 1909–1915. By Waldo L. Schmitt. Pp. 67+9 plates (New York City.)

Ceylon Journal of Science. Section B: Zoology and Geology Spolia Zeylanica Vol. 13, Part 3, March 31st Edited by Dr. Joseph Pearson Pp. 261-387+plates 10-21. (Colombo Colombo Museum, London: Dulau and Co, Ltd.) 3 rupees

Proceedings of the Isle of Wight Natural History Society for 1924. Vol. 1, Part 5 Pp. ccv-ccix+310-312. (Newport, I W: The County Press) 3s.

Hull Museum Publications, No. 87. Illustrated Catalogue of the Museum of Fisheries and Shipping, Pickering Park, Hull. By Thomas Sheppard Seventh edition Pp 73 (Hull.) 6d.

Ministry of Agriculture and Fisheries. Report on Salmon and Freshwater Fisheries for the Year 1924 Pp. 89. (London. H.M Stationery Office) 2s net.

The Institute of Actuaries. The Seventy-ninth Annual General Meeting, 7 June 1926: Report 1925–1926. Pp 6 (London.)

The Lister Institute of Preventive Medicine. Report of the Governing Body, 1926 Pp 24 (London)

The Carnegie Foundation for the Advancement of Teaching Bulletin No 17. Retiring Allowances for Officers and Teachers in Virginia Public Schools; a Study made at the Request of the Virginia State Teachers' Association and the State Board of Education By Clyde Furst, Raymond L. Mattocks and Howard J. Savage. Pp. vi+70 (New York City.)

Bergens Museum. Aarsberetning, 1924–1925. Pp 86. Bergens Museum Aarbok, 1924–1925. 2 Hefte. Naturvidenskabelig række. Pp. 85+81+78+4 Register til Bergens Museum Aarbok, 1883–1925 Pp 24. (Bergen A. S John Griegs Boktrykkeri.)

Annals of Eugenics: a Journal for the Scientific Study of Racial Problems. Edited by Karl Pearson, assisted by Ethel M Elderton. Vol 1, Parts 3 and 4. Pp 257-444. (London: Francis Galton Laboratory for National Eugenics, University College.) 35s. net

Contributions from the Jefferson Physical Laboratory and from the Cruft High-Tension Electrical Laboratory of Harvard University for the Years 1924 and 1925. Vol. 17. Pp vi+89 articles. (Cambridge, Mass)

Diary of Societies.

MONDAY, JUNE 28.

ROYAL IRISH ACADEMY, at 4.15.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION (at Finsbury Technical College), at 8.—C. A. Darling: The Rise of Atomic Physics (Silvanus Thompson Memorial Lecture).

THURSDAY, JULY 1.

ROYAL SOCIETY OF MEDICINE, at 5.—Annual General Meeting.

FRIDAY, JULY 2.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—J. A. Steers Orford Ness: A Study in Coastal Physiography.—L Richardson and W. F. Fleet. On Sandstones with Breccias below the Trias in South Warwickshire.—George Slater: Glacial Tectonics as reflected in Disturbed Drift Deposits. Part I. Preliminary Considerations.

SATURDAY, JULY 3.

BRITISH MYCOLOGICAL SOCIETY (Phytopathological Meeting) (at Harpenden)

PHYSIOLOGICAL SOCIETY (at Oxford).

CONFERENCES.

JULY 1 TO 2.

NATIONAL ASSOCIATION FOR THE PREVENTION OF TUBERCULOSIS (at Glasgow)—Dr. A. S. M. Macgregor, J. Taylor, and others: Discussion on the Provision for the Care of Non-Pulmonary Forms of Tuberculosis—Sir Robert Philip, Dr. L. Cox, and others: Discussion on the Actual Place and Function of the Tuberculosis Dispensary in the Tuberculosis Scheme.

JULY 2 AND 3.

INTERNATIONAL FEDERATION OF EUGENICS (at Paris)

Supplement to NATURE

No. 2933 JANUARY 16, 1926

Wordsworth's Interpretation of Nature.[1]

By Prof. WALTER GARSTANG, University of Leeds.

WORDSWORTH'S childhood and youth were spent with unusual freedom amid the sights and sounds of Nature, among hills and dales where inexhaustible variety of object and incident, grim as well as beautiful, is combined with an orderly repetition of conspicuous changes against a background of hard immutability. He revelled unchecked amid them all, "fostered alike by beauty and by fear."

His delight in Nature was closely akin to that which has inspired many famous naturalists, and his early sympathy with science was so clearly indicated that a slight turn of Fortune's wheel at the critical period of his life might well have made a naturalist of him instead of a poet. In 1785, when a happy schoolboy of fifteen, he eulogised from his Lakeland home

those Elysian plains
Where, throned in gold, immortal Science reigns,

and where Truth teaches

the curious soul
To search the mystic cause of things
And follow Nature to her secret springs;

and he records that two years later, when an undergraduate at Cambridge, with rooms over the College kitchens at St. John's, nightly from his pillow he could see beneath the stars

The antechapel where the statue stood
Of Newton with his prism and silent face,—
The marble index of a mind for ever
Voyaging through strange seas of thought, alone.
(The Prelude, III.)

His activities at Cambridge, however, remind one of Darwin's:

We sauntered, played or rioted; we talked
Unprofitable talk at morning hours;
Drifted about along the streets and walks,
Read lazily in trivial books, went forth
To gallop through the country in blind zeal
Of senseless horsemanship, or on the breast
Of Cam sailed boisterously, and let the stars
Come forth, perhaps without one quiet thought.

The academic fare, indeed, seems to have been of even less interest to him than to Darwin:

I did not love,
Judging not ill perhaps, the timid course
Of our scholastic studies; could have wished
To see the river flow with ampler range
And freer pace.

A question here presents itself. Had there been a Henslow in those days to take this sensitive, sociable, aimless youth in hand, would Wordsworth and the world have gained or lost? It cannot be doubted that he was in a state of mind in which a very slight change in the course of events might have guided his contemplation of Nature into scientific rather than poetic channels.

It is undoubtedly a fact that geometry gave him great pleasure at this time as it did later:

Specially delightful unto me
Was that clear synthesis built up aloft
So gracefully;
(Prel. VI.)

and the tribute of the Sage in "The Excursion" to the happiness of the naturalist may safely be taken to represent the poet's own feelings:

Happy is he who lives to understand
Not human nature only, but explores
All natures,—to the end that he may find
The law that governs each;
Through all the mighty commonwealth of things
Up from the creeping plant to sovereign man.
(Exc. IV.)

This is exactly the spirit that animated Darwin, the curiosity that has animated the master-minds of every science. But it is as true of science as of literature, that "for the creation of a master-work . . . two powers must concur, the power of the man and the power of the moment, and the man is not enough without the moment." The conditions, themselves a chapter of accidents, which determined the play of Darwin's spirit, never fell to Wordsworth. None had realised more vividly than he the ordered character of the living as of the inanimate universe, and of the interrelations between them; but there was as yet no beginning even of a biological "synthesis" to attract his imagination. Observation of detail, which to a later age acquired intellectual value, in Wordsworth's case simply enriched his emotions :

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[1] Presidential address to the Leeds Philosophical and Literary Society, October 20, 1925 (slightly abbreviated by the author).

> Contented if he might enjoy
> The things which others understand.
> (The Poet's Epitaph, 1799.)

So no special science was to tie him down. This nursling of the "mountains, lakes and sounding cataracts" was "ill-tutored for captivity." But, haunted by dear memories, he did not altogether forget his old nurse; and Nature, if intermittently, continued to be his teacher. Of his Cambridge days, Wordsworth writes :

> Oft when the dazzling show no longer new
> Had ceased to dazzle, ofttimes did I quit
> My comrades, leave the crowd, buildings and groves,
> And as I paced alone the level fields
> Far from those lovely sights and sounds sublime
> With which I had been conversant, the mind
> Drooped not . . .
> I looked for universal things ; perused
> The common countenance of earth and sky.
>
> . . . . . .
>
> I called on both to teach me what they might ;
> Or, turning the mind in upon herself,
> Pored, watched, expected, listened, spread my thoughts
> And spread them with a wider creeping ; felt
> Incumbencies more awful, visitings
> Of the Upholder of the tranquil soul
> That tolerates the indignities of Time,
> And, from the centre of Eternity
> All finite motions overruling, lives
> In glory immutable . . . the great mass
> Lay bedded in a quickening soul, and all
> That I beheld respired with inward meaning.
> (Prel. III.)

This vision, a development of the more generalised emotions of earlier years,—this ecstatic realisation of the "One in all," was, if I mistake not, the spring and source of Wordsworth's interpretation of Nature. The slight fence between science and poetry had been crossed, and in the Parnassian direction :

> I had a world about me—'twas my own :
> I made it, for it only lived to me,
> And to the God who sees into the heart.

From his Cambridge time onwards, humanity began to encroach upon Nature as his principal object of interest, a period of residence in London, followed by a still more important one in France during the throes of the Revolution, contributing powerfully to this result. Though indifferent at first, he was drawn into the ferment, took sides with the "patriots," and threw himself whole-heartedly into the revolutionary cause, to be dismayed in due course when he realised

> The indecision on their part whose aim
> Seemed best, and the straightforward path of those
> Who in attack or in defence were strong
> Through their impiety.
> (Prel. X.)

Robespierre was still in power when Wordsworth was recalled to London ("dragged by a chain of harsh necessity") to undergo the mortification of hearing England's declaration of war on the Republic, the first of many moral shocks he was now to undergo. He had witnessed the ushering in, through garlanded streets and rainbow arches, of a Utopia of Reason, Liberty and Light, and, while for some years cherishing his faith in the cause, saw the issue in a long-drawn welter of conflicting passions that knew no test of good and bad, of what to hope for, or of what to shun, in which every one was doomed to become "the dupe of folly or the slave of crime." With instincts and knowledge adequate enough for his guidance along the beaten tracks, now that all these were obliterated the cheerful faith with which he set out faltered ; he began to mistrust the very elevation of spirit which had linked him with

> Sage, warrior, patriot, hero ; for it seemed
> That their best virtues were not free from taint
> Of something false and weak, that could not stand
> The open eye of Reason.
> (Prel. XII.)

He sought deliberately to separate his past by a complete "gulph" from the nebulous future before him, and in the check which his emotional life had sustained, threw poetic dreams and prospects overboard :

> In such strange passion I warred against myself—
>
> . . . . . .
>
> Zealously laboured to cut off my heart
> From all the sources of her former strength.

He turned to philosophy and found himself able, as he says, "by syllogistic words"

> to unsoul
> Those mysteries of Being which have made,
> And shall continue evermore to make,
> Of the whole human race one brotherhood ;

and with remorseless logic scanned "even the visible Universe" with "microscopic view."

Simultaneously with this casting out of emotion, being "somewhat stern in temperament" and "bold to look on painful things," he made a renewed study of the whole framework of social life :

> Dragging all precepts, judgments, maxims, creeds,
> Like culprits to the bar ; calling the mind,
> Suspiciously, to establish in plain day
> Her titles and her honours ; now believing,
> Now disbelieving ; endlessly perplexed
> With impulse, motive, right and wrong, the ground
> Of obligation, what the rule and whence
> The sanction ; till, demanding formal *proof*,
> And seeking it in everything, I lost

All feeling of conviction, and, in fine,
Sick, wearied out with contrarieties,
Yielded up moral questions in despair.
(Prel. XI.)

The crisis was complete, and the upheaval of his life might well seem incapable of simple solution; yet it settled itself as quietly and insensibly as a wave of a summer sea. When Wordsworth returned to England after his two years in France, he was too deeply stirred to contemplate retirement to the country, and chose "the great City," where the general air was still agitated over the first unsuccessful attack on the slave trade. Here, as we have seen, he toiled through books and thoughts to find the solution of the problems of society which harassed him (1792–94). Finally, when he had brought himself to emptiness, hopelessness and scepticism, he turned to "abstract science" for relief and rejoined his sister Dorothy in Cumberland:

She whispered still that brightness would return;
She, in the midst of all, preserved me still
A Poet, made me seek beneath that name,
And that alone, my office upon earth;
And, lastly, . . . Nature's self,
By all varieties of human love
Assisted, led me back through opening day
To those sweet counsels between head and heart
Whence grew that genuine knowledge, fraught with peace,
Which, through the later sinkings of this cause,
Hath still upheld me, and upholds me now.
(Prel. XI.)

And this is how Nature worked:

Long time in search of knowledge did I range
The field of human life, in heart and mind
Benighted; but, the dawn beginning now
To reappear, 'twas proved that not in vain
I had been taught to reverence a Power
That is the visible quality and shape
And image of right reason; that matures
Her processes by steadfast laws; gives birth
To no impatient or fallacious hopes,
No heat of passion or excessive zeal,
No vain conceits; provokes to no quick turns
Of self-applauding intellect; but trains
To meekness, and exalts by humble faith;
Holds up before the mind intoxicate
With present objects, and the busy dance
Of things that pass away, a temperate show
Of objects that endure.

. . . .

Thus moderated, thus composed, I found
Once more in Man an object of delight,
Of pure imagination, and of love;
And, as the horizon of my mind enlarged,
Again I took the intellectual eye
For my instructor, studious more to see
Great truths, than touch and handle little ones.
Knowledge was given accordingly; my trust
Became more firm in feelings that had stood
The test of such a trial; clearer far
My sense of excellence—of right and wrong;
The promise of the present time retired
Into its true proportion; sanguine schemes,
Ambitious projects, pleased me less; I sought
For present good in life's familiar face,
And built thereon my hopes of good to come.
(Prel. XIII.)

Prof. Arthur Beatty, of Wisconsin, has recently published an elaborate study of Wordsworth's "Doctrine and Art in their Historical Relations," and makes one or two points which bear upon my topic. The poetic and doctrinal aspects of Wordsworth have frequently been regarded as hostile. Matthew Arnold, for example, "sought to establish the fame of the poet by ignoring his philosophy"; but the quotations I have given from "The Prelude" make it clear that with Wordsworth the attainment of a philosophy was essential to his poetry. In early youth he had caught the vision of the all-embracing unity of things, which was lost in France, and had to be regained before he could accomplish anything. He sought to get a true view of life as a whole, of man in relation to Nature, even as a part of Nature; and when he had acquired it, poetry was the expression of his attainment.

Philosophically, as Prof. Beatty claims, he revolted from the sentimental Rousseauist world into which he was born, or rather, into which he had strayed; and, poetically, he rebelled against the inflated language of his poetic predecessors. He was thus, in a twofold sense, a "poet of reaction," and the springs of both revolts were intimately related. His passion for reality and simplicity outside him had the same source as his love of truth and sincerity of thought within. These he himself attributed to his "education by Nature," which, as he says, from his "first dawn of childhood" did

interweave for me
The passions that build up our human soul
Not with the mean and vulgar works of man,
But with high objects, with enduring things—
With life and nature—purifying thus
The elements of feeling and of thought.
(Prel. I.)

For, having scanned,
Not heedlessly, the laws, and watched the forms,
Of Nature, in that knowledge I possessed
A standard, often usefully applied,
Even when unconsciously, to things removed
From a familiar sympathy.
(Prel. V.)

But Prof. Beatty goes into detail, and is not content to see in the poet's attitude the simple flowering of the vigorous germs implanted in his fervent youth. "In the sphere of Art," says Beatty, "he revolts against poetic diction and harks back to Milton and Shakespeare and Chaucer; in Doctrine he revolts against Rousseau and Godwin and appeals to Hartley, Locke, and the general tradition of English philosophy."

That Wordsworth followed Hartley and Locke in rejecting the doctrine of "innate ideas," and in recognising that early sensations and sense-impressions constitute the basis upon which the mind is built up by "association of ideas," Prof. Beatty has no difficulty in showing; but merely upon the evidences of this agreement, and of his frequent use of "associationist" language, to sum Wordsworth up as "the interpreter and poet of associationism" surely betrays a lack of perspective. So far as I can see, "associationism" was simply the ladder by which Wordsworth climbed out of the morass of sentimental idealism back to the point of view of his early vision: . . .

> Ye motions of delight, that haunt the sides
> Of the green hills; ye breezes and soft airs,
> Whose subtle intercourse with breathing flowers,
> Feelingly watched, might teach Man's haughty race
> How without injury to take, to give
> Without offence; . . . Ye brooks
> Muttering along the stones, a busy noise
> By day, a quiet sound in silent night;
> Ye waves . . .
> And you, ye groves, . . .
> Oh, that I had a music and a voice
> Harmonious as your own, that I might tell
> What ye have done for me. The morning shines,
> Nor heedeth Man's perverseness; Spring returns,—
> *I saw the Spring return.*
>
> (Prel. XII.)

This surely is the poet of Nature that speaks, not the poet of "associationism" or any other philosophical nostrum.

Put briefly, the argument and illustrations detailed at great length in "The Prelude" amount to this, that man is not outside Nature—the universe of law and order—but by his subtlest fabric intimately bound up with it. Divorce him in youth from free contact with external Nature and you rob him of Nature's predetermined means of conferring upon him his share of her own grandeur, modesty and tranquillity. (See "The Three Ages" below.)

In the laws of association Wordsworth thus found not only his intellectual means of escape from sentimentalism and "innate ideas," but also confirmation of his original vision. We are all members of the all-uniting whole, and the very machinery of the mind's processes is a proof of it.

Nature, indeed, was to Wordsworth a universal symphony, a harmony of infinitely varied elements, appealing to man through every sense and gateway to the heart. Some of his smaller poems, and innumerable passages in his longer works, are just so many phrases and passages isolated from the general symphony for special purposes. The musical analogy crops up incessantly:

> No sound is uttered,—but a deep
> And solemn harmony pervades
> The hollow vale from steep to steep
> And penetrates the glades.
>
> A soft eye-music of slow-waving boughs.

There are dominating themes and *motifs*; alternations, contrasts and developments of grandeur, tumult and tranquillity; but the meanest instrument has its part to play:

> To every Form of Being is assigned
> An active Principle. (Exc. IX.)

But the activity or influence of a particular thing is not regarded as something rigorously fixed and definable, as the function of an organ or a species may be defined by science. In his most exalted moods, Wordsworth has his mind concentrated on the whole, and, when he considers the parts, it is their interrelations and interactions that he is conscious of, not their boundaries or limitations.

Herein lies the essential difference between the scientific and the Wordsworthian outlook. Wordsworth is listening to the symphony, contemplating the pageant; science, closing eyes and ears to both, is engrossed in the operations of the separate instruments, in the make-up and doings of the individual agents. The reward to science is an increasing command over instruments and materials for practical purposes, as well as a growing understanding of the processes by which the symphony is rendered. But any message which the symphony, in its entirety, has to convey, is lost to the merely analytic intellect, for it appeals to emotion, and is only apprehended by emotion. Wordsworth, following the symphony "in a wise passiveness," drinks in its "thousand blended notes," is caught up, as it were, into its atmosphere of grandeur, order and beauty, experiences an exaltation of joy that defies expression, and knows that he has entered a gateway to the loftiest aspects of reality open to man:

> With an eye made quiet by the power
> Of harmony, and the deep power of joy,
> We see into the life of things.
>
> (Tintern Abbey.)

The mere analyst shrugs his shoulders before a self revelation of this order, and suggests an abnormal activity of endocrine glands. The utmost that he is entitled to say is that the emotions, like thought itself, are conditioned, and that to wise men, in intellectual and practical matters, they have proved more useful as incentives than as guides—a truth which barely touches Wordsworth's claim, namely, the value for human life of high emotion ("admiration, hope, and love") when disciplined by communion with Nature in her varied moods, and balanced, not suppressed, by knowledge and reflection:

This is the freedom of the Universe
Unfolded, still the more, more visible,
The more we know.

On the lower plane of cause and effect there is no antagonism between the two points of view, for Wordsworth's belief embraces in advance everything that science has established or may establish as to the orderly and interdependent character of the universe, whether viewed from without or from within. But on the higher plane, in the life of the emotions or spirit, the necessitarian chain simply drops away, and is seen as a mere substratum, conditioning results but not causing them. So long as imagination, or "faith," maintains itself as "feeling" in that upper level, science, at any rate, can interpose no obstacles to its flight.

Take, as a test, this slight vignette:

A humming bee, a little trickling rill,
A pair of falcons wheeling on the wing.

The matter-of-fact man will see in these two lines a mere catalogue of three disconnected and trivial things of no significance; but to the Nature-lover they call up, with superb artistry, a fragment of the great world-symphony—summer peace with its muted sounds and leisured motions. To appreciate that fragment, or, better still, its original, is to enter, through the gateway of emotion, a realm in which the proudest generalisations of science are simply irrelevant.

It may be urged, and has been urged, that our so-called peace is a delusion, and that Wordsworth cannot expect us to ignore that underneath the apparent Nature, with which he deals, is a real Nature "red in tooth and claw." This pointed phrase, as every good naturalist knows, is based on a complete misunderstanding of the nature of the "struggle for existence," and suggests that animal life is maintained at the cost of great cruelty and suffering, which is simply not true. In reality, as in appearance, animal life is essentially a world of bustling activity and wide-spread enjoyment. Sooner or later death comes to one and all, but in most cases quickly and unconsciously, as Alfred Russel Wallace pointed out long ago. Only in man, because he "looks before and after," does death necessarily entail an undercurrent of sadness and tragedy.

How death came to be a condition of life is a biological question, to which a fairly clear answer, from the point of view of cause and effect, can already be provided. That it should ever be so has troubled sensitive souls for ages, but Wordsworth's identification of divine and natural laws enabled him to face the problem with the equanimity of a modern Biologist:

Such ebb and flow must ever be,
Then wherefore should we mourn?
(Epitaphs, X., 1806.)

Our delight in the summer symphony may proceed, therefore, unchecked by any intellectual doubts as to the reality of the harmony presented to "eye and ear." That granted, no comment is needed on the supreme expression of Wordsworth's interpretation of the whole, except to notice how trouble and a richer human experience have softened the exuberance that glowed in the visionary moods of his youth:

For I have learned
To look on Nature, not as in the hour
Of thoughtless youth; but hearing oftentimes
The still, sad music of humanity,
Not harsh, nor grating, though of ample power
To chasten and subdue. And I have felt
A presence that disturbs me with the joy
Of elevated thoughts; a sense sublime
Of something far more deeply interfused,
Whose dwelling is the light of setting suns,
And the round ocean and the living air,
And the blue sky, and in the mind of man;
A motion and a spirit, that impels
All thinking things, all objects of all thought,
And rolls through all things.
(Tintern Abbey.)

At this point it is natural and relevant to refer to an element in Wordsworth's doctrine which first finds expression in this beautiful poem, and plays a large and integral part in his conception of the relations between man and Nature—his emphasis on the distinctive qualities of the "Three Ages of Man." By tracing out, and correlating, the many passages, both of prose and verse, in which Wordsworth's ideas on this point are expressed, Prof. Beatty has discharged a critical task of great service to serious students of the poet. Stated briefly, and with special reference to my own theme, the point is this, that in the individual development of mind and character three stages are passed through: animal childhood (receptive and experimental); emotional (or "sentient") youth, and reflective (or "intellectual") maturity; and that, while each stage exhibits its own distinctive features, the mind only attains its complete fullness and efficiency if the earlier stages have been allowed free scope under conditions suited to make the most of their respective qualities—"The higher mode of being does not exclude, but necessarily includes, the lower: the intellectual does not exclude, but necessarily includes, the sentient; the sentient, the animal. . . ." (Wordsworth, "Convention of Cintra," 1809.)

The recognition of this principle doubtless came to Wordsworth during the period when he was clearing his mind after its unsettlement by his revolutionary experiences, and is bound up with his adoption of Hartley's "associationism." Its discovery, with all its implications, seems to have co-ordinated and stimulated the poet's thoughts and animated his poetry, as profoundly as the theory of recapitulation affected the zoological world of a later generation. It was the idea of a necessary developmental sequence; and it not only resolved for him a number of hitherto perplexing problems, as set forth at length in "The Prelude," but also became the sheet-anchor of his perennial optimism, as exemplified in the fourth book of "The Excursion."

To it we owe not only its quintessential expression in "The Rainbow" (1802: "The Child is father of the Man"), and the sustained splendour of the famous Ode on "Intimations of Immortality" (1802–6), but also many other of the poet's most characteristic and sonorous lines:

> Dust as we are, the immortal spirit grows
> Like harmony in music. . . .
> (Prel. I.)

It is because the impressions incidentally received in childhood (*e.g.* during bathing, skating, trapping, nutting, etc.) may give so powerful a turn to the emotions of youth as to affect, for better or worse, the mind of manhood, that Wordsworth attaches so much importance to early association with Nature. The child is thus, under natural conditions, Nature's link between herself and man.

If the immortal "Ode" be re-read in the light of these remarks, it will be observed that the first four stanzas, which, according to Wordsworth himself, were written "two years at least" before the remainder, convey no sentiment at variance with this general idea. Indeed, this is just the idea which these four stanzas do so glowingly express—the identification of childhood with the glory and joy of Nature, and the more distant sympathy between Nature and manhood:

> The first diviner influence of this world,
> As it appears to unaccustomed eyes.
> (Prel. XII.)

The association of the idea of pre-existence with the "visionary gleam" of childhood was a "poetic" afterthought; and was intended, as Wordsworth himself has assured us, rather to emphasise than to explain the "dream-like" qualities of sight and feeling with which a child's mind explores the realities of the "not-self." In that case the poet very greatly overshot the mark, both by the extent to which he carried his apotheosis of the child, and by incorporating the idea in later versions of the title. Not all the poet's skill and sustained beauty of language have been able to blend the two voices speaking in this famous "Ode." In particular, as various critics have pointed out, the second group of four stanzas (v.-viii.) is, in effect, an interpolation, alien to the poet's whole philosophy of life, and inconsistent with both the opening and closing sections of the poem. By exaggerating the divinity of the child, he is compelled in those stanzas to treat the attainment of manhood in terms of loss instead of gain, whereas in the noble peroration of the "Ode," as well as everywhere else, the "years that bring the philosophic mind" are regarded as bringing with them an access of serenity and power and human sympathy which more than compensates for the loss of the "dizzy raptures" of youth.

It is remarkable that the zoological theory of "recapitulation" has undergone, and is still undergoing, the same criticism as that which has been applied to Wordsworth's "Ode," and is being steadily pruned of elements which exaggerate the ancestral significance of developmental features. In a brief criticism of the "Ode," the general result of which is not at variance with that expressed in my last paragraph, Dean Inge implies that the qualities of childhood, which Wordsworth exalts as reminiscences of its "ancestral home," may include racial instincts "which do not arise from his own (*i.e.* the child's) experience in his present life." So far as the "interpolated" stanzas are concerned, however, the reference is not just to "animal spirits," but to

> those obstinate questionings
> Of sense and outward things,
> Fallings from us, vanishings;
> Blank misgivings of a Creature
> Moving about in worlds unrealised;

and these, as is clear from the special incidents which Wordsworth recalls in his prefatory note, are not "ancestral" traits at all, but the inevitable reactions of any mind, in its first intense subjectivity, when groping its way to the perception of external reality. The more sensitive mind naturally reacts more strikingly.

From some of his more familiar poems it might be inferred that Wordsworth's attitude towards science was one of indifference, if not of contempt, *e.g.*

> Enough of Science and of Art;
> Close up those barren leaves.
> (Lyrical Ballads, 1798.)

This inference would not lack support from certain passages in "The Excursion" (Books III. and IV.).

It is equally true, however, that Wordsworth took a lofty view of the functions both of poetry and of science, and his tributes to the actual geometry and the potential biology of his time have already been quoted. In the famous preface to the second edition of "Lyrical Ballads" (1800), he tells us that the poet is as much concerned in the spread of truth as the man of science, but truth of a different and more general order, "not standing upon external testimony, but carried into the heart by passion, truth which is its own testimony, appealing to the knowledge which all men carry about with them, and to those sympathies in which, without any other discipline than that of our daily life, we are fitted to take delight."

"The remotest discoveries of the Chemist, the Botanist, or Mineralogist, will be as proper objects of the Poet's art as any upon which it can be employed, if the time should ever come when these things shall be familiar to us, and the relations under which they are contemplated . . . shall be manifestly and palpably material to us as enjoying and suffering beings."

These quotations (nearly, but not quite, *verbatim*) are enough to show that, whether Wordsworth's point of view be accepted or not, he had a vision in his mind which was not unfriendly to the development of science, even though, as he said, he would be unable to make use of science until, in its various branches, it had made some degree of progress intelligible and familiar to the common man.

Passages like that already quoted from "Lyrical Ballads," or the half-sarcastic description in "The Excursion" (Bk. III.) of the botanist and the geologist of his time, are robbed of their sting when it is remembered that Wordsworth began to write in the eighteenth century, when few of the natural sciences had given any signal proof of their value to men "as enjoying and suffering beings." It was the age of Linneus, who was still alive in Wordsworth's youth. All the sciences were still at work upon their foundations, engrossed in distinguishing gases, analysing substances into their elements, describing and classifying species generally. They wore the aspect, to all but the initiated, of elegant pastimes or harmless hobbies.

It could scarcely be expected that the poet Wordsworth, appealing to emotion with a gospel of Nature that was the refined expression of vivid experience, should find an atmosphere "in which to move his wings" in analytic researches—

> Where soul is dead, and feeling hath no place ;
> Where knowledge, ill begun in cold remark
> On outward things, with formal inference ends.
> (Exc. IV.)

Nevertheless, it was less the act of analysis than contentment with analysis that Wordsworth decried, and there are many passages in his later writings which suggest that his early appreciation of science grew stronger as time passed :

> To reinstate wild Fancy, would we hide
> Truths whose thick veil Science has drawn aside ?
> (1833.)

Explicit references to scientific discoveries are not numerous, but the following are interesting examples of Wordsworth's poetic use of them. We have already noted his admiration of Newton. In his account of the babe in his mother's arms, he characteristically refers to "gravitation" as one of the bonds "that connect him [*i.e.* the babe] with the world" (Prel. II.).

In his poem "To the Small Celandine" (1803) there is a playful comparison between the poet's "discovery" of this flower and the stir made on the "sage astronomer's" finding of a new star. The allusion is obviously to Herschel's discovery of Uranus (1781).

Similarly, as was first pointed out to me by my blind botanical friend Mr. J. G. Wilkinson, the poet's many references to the "breathing" of flowers—one of which has been quoted already (p. 4)—are probably based on the results of Joseph Priestley's experiments (1775)—"the philosophic Priestley" of Wordsworth's "Apology for the French Revolution" (1793). One of the poems which contains an allusion to "breathing flowers" is "This Lawn, a carpet all alive" (1829), and in the Fenwick note to this (1843) the poet remarks : "The beauty in form of a plant or an animal is not made less but more apparent as a whole by more accurate insight into its constituent properties and powers."

So far it has been possible to discuss Wordsworth's interpretation of Nature without considering the special use which the poet makes of particular details. We have seen, however, that while his general idea of Nature can be appropriately likened to that of a symphony, or, rather, an interacting harmony of sense-impressions generally, he also regarded each part of Nature, each "Form of Being," animate and inanimate, as discharging an "active" function. His clear, imaginative vision, and mastery of word and phrase, are never more telling than in those descriptions of Nature, scattered through all his larger works, in which the influences of natural objects are made manifest without the need of a single didactic word. As Matthew Arnold so aptly said : "Nature herself seems to take the pen out of his hand, and to write for him with her own bare, sheer, penetrating power."

When in his smaller poems Wordsworth singles out particular "Forms of Being" for special eulogy, a change of tone is at once apparent ; the poet ceases to be the perfect mouthpiece of Nature, and, allowing freer play to fancy, tends to become the conscious teacher and moralist. It is not his special interest in "life's familiar face" that betrays him. On the contrary, to reveal new charms in the common-place strengthens his claims to be Nature's own interpreter. But Nature endows all her children with distinctive charms, each admirable in its sphere ; and the false note creeps in when the moralist, with his single scale of human values, seeks to compare one flower with another, one bird with another, not from the relative efficiency with which they play their parts, but from their fancied approximation to points in the human code.

The Lesser Celandine, pleasing him at first, and naturally, as a bright harbinger of spring, becomes a type of meekness and humility in contrast to the self-advertising buttercup, "of the flaring hours" (the "little children's flower" of Browning !). On the other hand the "cheerful" Daisy is praised for its very ubiquity at every season, while Violets "in their secret mews" ("modest" for every other poet !) are dismissed with a suggestion of encouraging the "wanton zephyrs." Similarly the fiery eloquence of the nightingale is rejected on one occasion for the "pensive" cooing of the stockdove, and on another for the "pilgrim" strains of the skylark, "true to the kindred points of heaven and home."

Treatment of this kind is obviously not interpretation of Nature, but self-expression, with natural objects employed as symbols. It differs little in essence from the "emblematic" treatment of Nature by the poet's predecessors, and carries with it an artificial flavour of the domestic garden, instead of the atmosphere of Nature herself. Even in these flights of fancy and imagination, however, Wordsworth always goes directly to Nature for his emblems and types, and not to the traditional stock, and his observant eye picks out real and distinctive features on which his reflections are based or his fancy plays.

As a typical example of this latter point may be cited his poem on the familiar "Herb Robert," with its shining red stems, which enable "Poor Robin," as he calls it,

> his part to fill;
> Cheerful alike if bare of flowers as now,
> Or when his tiny gems shall deck his brow.

But best of all his smaller Nature-poems, because simply lyrical, is, to my mind, his poem on the greenfinch ("Green Linnet"), in which he makes delightful play with the bird's liveliness, protective colouring, and characteristic discontinuity of song:

> My dazzled sight he oft deceives,
> A brother of the dancing leaves;
> Then flits, and from the cottage eaves
> Pours forth his song in gushes.

In fact, as the late Sir Walter Raleigh said, "the spirit of science has found no loftier or loyaller prophet than Wordsworth," and I venture to hope that this examination of Wordsworth's message and methods by one of themselves may not be altogether indifferent to the votaries of science. With zeal as undivided as theirs he pursued the same goal, truth; in accuracy and range of observation, no less than in fidelity of description, he was as scrupulous as the best, and equally critical (but not neglectful) of speculation and romance. Indeed, though poetic to the core, he risked reputation and fame by insisting that poetic creations must be based on the facts and realities of the world "as they are," and not as unchecked fancy may depict them—an axiom of his to which NATURE pays weekly tribute:

> To the solid ground
> Of Nature trusts the Mind that builds for aye;
> Convinced that there, there only, she can lay
> Secure foundations.
>
> (Misc. Sonnets, XXXIV.)

Wordsworth's whole gospel, indeed, might be summed up in some such terms as these: Learn the order of Nature; recognise the fixity of her laws, and then conform. Do these things, however, not with a cold and formal spirit, kicking against the pricks of stern necessity, but with a "feeling intellect" that first learns to admire the grandeur and harmony of Nature's order, and then aspires to achieve them in the distracted fields of human life:

> This prayer I make,
> Knowing that Nature never did betray
> The heart that loved her; 'tis her privilege
> Through all the years of this our life, to lead
> From joy to joy: for she can so inform
> The mind that is within us, so impress
> With quietness and beauty, and so feed
> With lofty thoughts, that neither evil tongues,
> Rash judgments, nor the sneers of selfish men,
> Nor greeting where no kindness is, nor all
> The dreary intercourse of daily life,
> Shall e'er prevail against us, or disturb
> Our cheerful faith, that all which we behold
> Is full of blessings.
>
> (Tintern Abbey, 1798.)

The facts confronting the poet and the man of science are the same, Nature and man,—man the inhabitant of Nature, and Nature the environment and nurse of man,—but each acting and reacting on the other, and together building up "this transcendent universe." To understand this unity is the task of poetry and science alike. But while science sets no term to its efforts, and the life-work of a single investigator is spent upon a mere fragment or two of the ultimate edifice, the poet, when he claims his ancient rôle, feels bidden to present to his age and generation a synthesis, of which the corners have been rounded by insight and feeling, where the inductions of science are still, and may be for ever, wanting. This aim may be incapable of complete attainment, but it is neither futile nor unwelcome in the attempt, provided the poet be equipped for his task by long, close and sympathetic converse with Nature and man, and that he be one

> who looks
> In steadiness, who hath among least things
> An undersense of greatest; sees the parts
> As parts, but with a feeling of the whole.

It is precisely because he fulfilled these requirements that Wordsworth still claims our attention.

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Primitive Law and Order.[1]

By Dr. B. MALINOWSKI.

SAVAGERY to most people is still synonymous with absurd, cruel, and eccentric customs, with quaint superstitions and revolting practices. Sexual licence, infanticide, head-hunting, couvade, cannibalism and what not, have made anthropology attractive reading to many, a subject of curiosity rather than of serious scholarship to others. A fuller knowledge of the so-called savages, however, has revealed "Ye beastly devices of Ye heathen" as the product of firm law and of strict tradition, due to biological, mental and social needs of human nature, rather than as the outcome of unbridled passion and unfettered excess. Law and order pervade the tribal usages of primitive races, they govern all the humdrum course of daily existence, as well as the leading acts of public life, whether these be quaint and sensational or merely important and venerable.

THE AUTOMATIC SUBMISSION TO CUSTOM AND THE REAL PROBLEM.

When we come to inquire why rules of conduct, however hard, irksome, or unwelcome, are obeyed; what makes private life, economic co-operation, public events run so smoothly; of what, in short, consist the forces of law and order in savagery—the answer is not so easy to give, and what anthropology has had to say about it is far from satisfactory. So long as it could be maintained that the 'savage' is really savage, that he follows what little law he has but fitfully and loosely, the problem did not exist. When the question became actual, when it became plain that hypertrophy of rules rather than lawlessness is characteristic of primitive life, scientific opinion casting for new bearings veered round to the opposite point: the savage was made not only into a model of the law-abiding citizen, but it also became an axiom that in submitting to all his tribal rules and fetters, he follows the natural trend of his spontaneous impulses; that in this way he glides, so to speak, along the line of least resistance.

The savage—so runs to-day's verdict of competent anthropologists—has a deep reverence for tradition and custom, an automatic submission to their biddings. He obeys them "slavishly," "unwittingly," "spontaneously," through "mental inertia," combined with the fear of public opinion or of supernatural punishment (Sidney Hartland); or again through a "pervading group-sentiment if not group-instinct" (Rivers). I have already in a previous article stated the views of such contemporary writers as Hobhouse, Rivers, Sidney Hartland and Lowie, and I have submitted them to a searching criticism and have arrived at the conclusion that neither the way in which the problem has been set forth, nor the solutions given, can be regarded as adequate.[2] I have also tried to make it clear that any shortcomings in theory or observation are due to the real difficulties and pitfalls of which this subject is so full.

The extreme difficulty of the problem lies, I think, in the very complex and diffuse nature of the forces which constitute primitive law. Accustomed as we are to look for a definite machinery of enactment, administration, and enforcement of law, we cast round for something analogous in a savage community and, failing to find there any similar arrangements, we conclude that all law is obeyed by this mysterious propensity of the savage to obey it.

Anthropology seems here to be faced by a similar difficulty as the one overcome by Tylor in his "minimum definition of religion." By defining the forces of law in terms of central authority, codes, courts, and constables, we must come to the conclusion that law needs no enforcement in a primitive community and is followed spontaneously. That the savage does break the law sometimes, though rarely and occasionally, has been recorded by observers and taken into account by builders of anthropological theory, who have always maintained that criminal law is the only law of savages. But that his observance of the rules of law under the normal conditions, when it is followed and not defied, is at best partial, conditional, and subject to evasions; that it is not enforced by any wholesale motive like fear of punishment, or a general submission to all tradition, but by very complex psychological and social inducements—all this is a state of affairs which modern anthropology has so far completely overlooked. In the following account I shall try to establish it for one ethnographic province, north-west Melanesia, and I shall show reasons why observations of similar nature to those carried out by myself should be extended to other societies in order to give us some idea about their legal conditions.

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[1] The present article contains the substance, expanded and recast, of a discourse delivered before the Royal Institution on Friday, February 13, 1925. I wish to express my indebtedness to the Laura Spelman Rockefeller Memorial for the assistance given me in carrying out this investigation.

[2] See NATURE, August 15, 1925, p. 230, review entitled "Primitive Law."

We shall approach our facts with a very elastic and wide conception of the problem before us. In looking for 'law' and legal forces, we shall try merely to discover and analyse all the rules conceived and acted upon as binding obligations, to find out the nature of the binding forces, and to classify the rules according to the manner in which they are made valid. We shall see that by an inductive examination of facts, carried out without any preconceived idea or ready-made definition, we shall be enabled to arrive at a satisfactory classification of the norms and rules of a primitive community, at a clear distinction of primitive law from other forms of custom, and at a new, dynamic conception of the social organisation of savages. Since the facts of primitive law described in this article have been recorded in Melanesia, the classical area of 'communism' and 'promiscuity,' of 'group-sentiment' and 'clan-solidarity,' of 'spontaneous obedience' and what not, the conclusions we shall be able to draw—which will dispose of these catch-words and all they stand for—may be of special interest.

MELANESIAN ECONOMICS AND THE THEORY OF PRIMITIVE COMMUNISM.

The Trobriand Archipelago, which is inhabited by the Melanesian community referred to, lies to the north-east of New Guinea and consists of a group of flat coral islands, surrounding a wide lagoon. The plains of the land are covered with fertile soil and the lagoon teems with fish, while both afford easy means of intercommunication to the inhabitants. Accordingly, the islands support a dense population mainly engaged in agriculture and fishing, but expert also in various arts and crafts and keen on trade and exchange.

Like all coral islanders, they spend a great deal of their time on the central lagoon. On a calm day it is alive with canoes carrying people or produce, or engaged in one of their manifold systems of fishing. A superficial acquaintance with these pursuits might leave one with an impression of arbitrary disorder, anarchy, complete lack of system. Patient and painstaking observations would soon reveal, however, not only that the natives have definite technical systems of catching fish and complex economic arrangements, but also that they have a close organisation in their working teams, and a fixed division of social functions.

Thus, within each canoe it would be found that there is one man who is its rightful owner, while the rest act as a crew. All these men, who as a rule belong to the same sub-clan, are bound to each other and to their fellow-villagers by mutual obligations: when the whole community go out fishing, the owner cannot refuse his canoe. He must go out himself or let some one else do it instead. The crew are equally under an obligation to him. For reasons which will presently become clear, each man must fill his place and stand by his task. Each man also receives his fair share in the distribution of the catch as an equivalent of his service. Thus the ownership and the use of the canoe consist of a series of definite obligations and duties uniting a group of people into a working team.

What makes the conditions even more complex is that the owners and the members of the crew are entitled to surrender their privileges to any one of their relatives and friends. This is often done, but always for a consideration, for a repayment. To an observer who does not grasp all the details, and does not follow all the intricacies of each transaction, such a state of affairs looks very much like communism: the canoe appears to be owned jointly by a group and used indiscriminately by the whole community.

Dr. Rivers in fact tells us that "one of the objects of Melanesian culture which is usually, if not always, the subject of common ownership is the canoe," and further on, in reference to this statement, he speaks about "the great extent to which communistic sentiments concerning property dominate the people of Melanesia" ("Social Organisation," pp. 106 and 107). In another work, the same writer speaks about "the socialistic or even communistic behaviour of such societies as those of Melanesia" ("Psychology and Politics," pp. 86 and 87). Nothing could be more mistaken than such generalisations. There is a strict distinction and definition in the rights of every one, and this makes ownership anything but communistic. We have in Melanesia a compound and complex system of holding property, which in no way partakes of the nature of 'socialism' or 'communism.' A modern joint-stock company might just as well be called a 'communistic enterprise.' As a matter of fact, any descriptions of a savage institution in terms such as 'communism,' 'capitalism,' 'joint-stock company,' or what not, borrowed from present-day economic conditions or political controversy, cannot be but misleading.

The only correct proceeding is to describe the legal state of affairs in terms of concrete fact. Thus, the ownership of a Trobriand fishing canoe is defined by the manner in which the object is made, used and regarded with reference to the group of men who produced it and enjoy its possession. The master of the canoe, who acts at the same time as the head of the team and as the fishing magician of the canoe, has first of all to finance the building of a new craft, when the old one is worn out, and he has to maintain it in good repair, helped in this by the rest of his crew. In this they remain under mutual obligations to one another, to appear each at his post, while every canoe is bound to come when a communal fishing has been arranged.

In using the craft, every joint owner has a right to a certain place in it and to certain duties, privileges, and benefits associated with it. He has his post in the canoe, he has his task to perform, and enjoys the corresponding title, either of 'master' or 'steersman,' or 'keeper of the nets,' or 'watcher for fish.' His position and title are determined by the combined action of rank, age, and personal ability. Each canoe also has its place in the fleet and its part to play in the manœuvres of joint fishing. Thus on a close inquiry we discover in this pursuit a definite system of division of functions and a rigid system of mutual obligations, into which a sense of duty and the recognition of the need of co-operation enter side by side with a realisation of self-interest, privileges, and benefits. Ownership, therefore, can be defined neither by such words as 'communism' or 'individualism,' nor by reference to 'joint-stock company' system or 'personal enterprise,' but by the concrete facts and conditions of use. It is the sum of duties, privileges, and mutualities which bind the joint owners to the object and to each other.

Thus, in connexion with the first object which attracted our attention—the native canoe—we are met by law, order, definite privileges, and a well-developed system of obligations.

THE BINDING FORCE OF ECONOMIC OBLIGATIONS.

To enter more deeply into the nature of these binding obligations, let us follow the fishermen to the shore. Let us see what happens with the division of the catch. In most cases only a small proportion of it remains with the villagers. As a rule we should find a number of people from some inland community waiting on the shore. They receive the bundles of fish from the fisherman and carry them home, often many miles away, running so as to arrive while it is still fresh. Here again we should find a system of mutual services and obligations based on a standing arrangement between two village communities. The inland village supplies the fishermen with vegetables: the coastal community repays with fish. This arrangement is primarily an economic one. It has also a ceremonial aspect, for the exchange has to be done according to an elaborate ritual. But there is also the legal side, a system of mutual obligations which forces the fisherman to repay whenever he has received a gift from his inland partner, and vice versa. Neither partner can refuse, neither may stint in his return gift, neither should delay.

What is the motive force behind these obligations? The coastal and inland villages respectively have to rely upon each other for the supply of food. On the coast the natives never have enough vegetable food, while inland the people are always in need of fish. Moreover, custom will have it that on the coast all the big ceremonial displays and distributions of food, which form an extremely important aspect of the public life of these natives, must be made with certain specially large and fine varieties of vegetable food, which grow only on the fertile plains inland. There, on the other hand, the proper substance for a distribution and feast is fish. Thus to all other reasons of value of the respectively rarer food, there is added an artificially, culturally created dependence of the two districts upon one another. So that on the whole each community is very much in need of its partners. If at any time previously these have been guilty of neglect, however, they know that they will be in one way or another severely penalised. Each community has, therefore, a weapon for the enforcement of its rights: reciprocity.

This is not limited to the exchange of fish for vegetables. As a rule, two communities rely upon each other in other forms of trading and other mutual services as well. Thus every chain of reciprocity is made the more stringent by being part and parcel of a whole system of mutualities.

RECIPROCITY AND DUAL ORGANISATION.

I have found only one writer who fully appreciates the importance of reciprocity in primitive social organisation. The leading German anthropologist, Prof. Thurnwald of Berlin, clearly recognises "die Symmetrie des Gesellschaftsbaus" and the corresponding "Symmetrie von Handlungen." "Die Symmetrie von Handlungen aber nennen wir das Prinzip der Vergeltung. Dieses liegt tief verwurzelt im menschlichen Empfinden—als adäquate Reaktion—und ihm kam von jeher die grösste Bedeutung im sozialen Leben zu." ("Die Gemeinde der Bánaro," Stuttgart, 1921, p. 16). Throughout his monograph, which by the way is perhaps the best account of the social organisation of a savage tribe extant, Prof. Thurnwald shows how the symmetry of social structure and of actions pervades native life. Its importance as a legal binding form is not, however, explicitly stated by the writer, who seems to be aware of its psychological foundation "in human feeling," rather than of its social function in safeguarding the continuity and adequacy of mutual services.

The old theories of tribal dichotomy, the discussions about the 'origins' of 'phratries' or 'moieties' and of the duality in tribal subdivisions, never entered into the inner or differential foundations of the external phenomenon of halving. The recent treatment of the "dual organisation" by the late Dr. Rivers and his school suffers badly from the defect of looking for recondite causes instead of analysing the phenomenon itself. The dual principle is neither the result of "fusion" or "splitting" nor of any other sociological cataclysm. It is the integral result of the inner symmetry of all social transactions, of the reciprocity of services, without which no primitive community could exist. A dual organisation may appear clearly in the division of a tribe into two 'moieties' or be almost completely obliterated—but I venture to foretell that wherever careful inquiry be made, symmetry of structure will be found in every savage society, as the indispensable basis of reciprocal obligations.

The sociological manner in which the relations of reciprocity are arranged makes them yet more stringent. Between the two communities the exchanges are not carried out haphazard, any two individuals trading with each other at random. On the contrary, every man has his permanent partner in the exchange, and the two have to deal with each other. They are often relatives-in-law, or else sworn friends, or partners in the important system of ceremonial exchange called *kula*. Within each community again, the individual partners are ranged into totemic subclans. So that the exchange establishes a system of sociological ties of economic nature, often combined with other ties, between individual and individual, kinship group and kinship group, village and village, district and district.

Going over the relations and transactions previously described, it is easy to see that the same principle of mutuality supplies the sanction to each rule. There is in every act as well as at the basis of every status a sociological dualism: two parties who exchange services and functions, each watching over the measure of fulfilment and the fairness of conduct of the other. The master of the canoe, whose interests and ambitions are bound up with his craft, looks after order in the internal transactions between the members of the crew and represents the latter externally. To him each member of the crew is bound at the time of construction and ever after, when co-operation is necessary. Reciprocally, the master has to give each man the ceremonial payment at the feast of construction; the master cannot refuse any one his place in the boat; and he has to see that each man receives his fair share of the catch. In this and in all the manifold activities of economic order, the social behaviour of the natives is based on a well-assessed give-and-take, always mentally ticked off and in the long run balanced. There is no wholesale discharge of duties or acceptance of privileges; no 'communistic' disregard of tally and ear-mark. The free and easy way in which all transactions are done, the good manners which pervade all and cover any hitches or maladjustments, make it difficult for the superficial observer to see the keen self-interest and watchful reckoning which runs right through. To one who knows the natives intimately, nothing is more patent than this. The same control which the master assumes within his canoe, is taken within the community by the headman who is, as a rule, also the hereditary magician.

Law, Self-interest, and Social Ambition.

It scarcely needs to be added that there are also other driving motives, besides the constraint of reciprocal obligations, which keep the fishermen to their task. The utility of the pursuit, the craving for the fresh, excellent diet, above all, perhaps, the fascination of what to the natives is an intensely fascinating sport—move them more obviously, more consciously even, and more effectively than what we have described as the legal obligation. But the social constraint, the regard for the effective rights and claims of others is always prominent in the mind of the natives as well as in their behaviour, once this is well understood. It is also indispensable to ensure the smooth working of their institutions. For in spite of all zest and attractions, there are on each occasion a few individuals, indisposed, moody, obsessed by some other interest—very often by an intrigue—who would like to escape from their obligation, if they could. Any one who knows how extremely difficult, if not impossible, it is to organise a body of Melanesians for even a short and amusing pursuit requiring concerted action, and how well and readily they set to work in their customary enterprises, will realise the function and the need of compulsion, due to the native's conviction that another man has a claim on his work.

There is yet another force which makes the obligations still more binding. I have mentioned already the ceremonial aspect of the transactions. The gifts of food in the system of exchange described above must be offered according to strict formalities, in specially made measures of wood, carried and presented in a prescribed manner, in a ceremonial procession and with a blast of conch-shells. Now nothing has a greater sway over the Melanesian's mind than ambition and vanity associated with a display of food and wealth. In the giving of gifts, in the distribution of their surplus, they feel a manifestation of power, and an enhancement of personality. The Trobriander keeps his food in houses better made and more highly ornamented than his dwelling huts Generosity is the highest virtue to him, and wealth the essential element of influence and rank. The association of a semi-commercial transaction with definite public ceremonies supplies another binding force of fulfilment through a special psychological mechanism: the desire for display, the ambition to appear munificent, the extreme esteem for wealth and for the accumulation of food.

We have thus gained some insight into the nature of the mental and social forces which make certain rules of conduct into binding law. Nor is the binding force superfluous. Whenever the native can evade his obligations without the loss of prestige, or without the prospective loss of gain, he does so, exactly as a civilised business man would do. When the "automatic smoothness" in the run of obligations so often attributed to the Melanesian is studied more closely, it becomes clear that there are constant hitches in the transactions, that there is much grumbling and recrimination and seldom is a man completely satisfied with his partner. But, on the whole, he continues in the partnership and, on the whole, every one tries to fulfil his obligations, for he is impelled to do so, partly through enlightened self-interest, partly in obedience to his social ambitions and sentiments. Take the real savage, keen on evading his duties, swaggering and boastful when he has fulfilled them, and compare him with the anthropologist's dummy who slavishly follows custom and automatically obeys every regulation. There is not the remotest resemblance between the teachings of anthropology on this subject and the reality of native life. We begin to see how the dogma of mechanical obedience to law would prevent the field-worker from seeing the really relevant facts of primitive legal organisation. We understand now that the rules of law, the rules with a definite binding obligation, stand out from the mere rules of custom. We can see also that civil law, consisting of positive ordinances, is much more developed than the body of mere prohibitions, and that a study of criminal law alone among savages misses the most important phenomena of their legal life.

It is also obvious that the type of rules which we have been discussing, although they are unquestionably rules of binding law, have in no way the character of religious commandments, laid down absolutely, obeyed rigidly and integrally.[3] The rules here described are essentially elastic, adjustable, and they leave a considerable latitude within which their fulfilment is regarded as satisfactory. The bundles of fish, the measures of yams, or bunches of taro, can only be roughly assessed, and naturally the quantities exchanged vary according to whether the fishing season or the harvest is more abundant. All this is taken into account and only wilful stinginess, neglect, or laziness are regarded as a breach of contract. Since again, largesse is a matter of honour and praise, the average native will strain all his resources to be lavish in his measure. He knows, moreover, that any excess in zeal and generosity is bound to be sooner or later rewarded.

We can see now that a narrow and rigid conception of the problem—a definition of 'law' as the machinery of carrying out justice in cases of trespass—would leave on one side all the phenomena to which we have referred In all facts described, the element or aspect of law, that is, of effective social constraint, consists in the complex arrangements which make people keep to their obligations. Among them the most important is the manner in which many transactions are linked into chains of mutual services, every one of them having to be repaid at some later date. The public and ceremonial manner in which these transactions are usually carried out, combined with the great ambition and vanity of the Melanesian, adds also to the safeguarding forces of law.

THE RULES OF LAW IN RELIGIOUS ACTS.

I have referred so far mainly to economic relations, for civil law is primarily concerned with ownership and wealth among savages as well as among ourselves. But we could find the legal aspect in any other domain of tribal life. Take, for example, the most characteristic acts of ceremonial life—the rites of mourning and sorrow for the dead. At first we perceive in them, naturally, their religious character: they are acts of piety towards the deceased, caused by fear or love or solicitude for the spirit of the departed As ritual and public display of emotion, they are also part of the ceremonial life of the community.

Who, however, would suspect a legal side to such religious transactions? Yet in the Trobriands there is not one single mortuary act, not one ceremony, which is not considered to be an obligation of the performer towards some of the other survivors. The widow weeps and wails in ceremonial sorrow, in religious piety and fear—but also because the strength of her grief affords direct satisfaction to the deceased man's brothers and maternal relatives. It is the matrilineal group of kindred who, according to the native theory of kinship and mourning, are the people really bereaved. The wife, though she lived with her husband, though she should grieve at his death, though often she really and sincerely does so, remains but a stranger, by the rules of matrilineal kinship. It is her duty towards the surviving members of her husband's clan, accordingly, to display her grief, to keep a long period of mourning and to carry the jaw-bone of her husband for some years after his death. Nor is this obligation without reciprocity. At the first big ceremonial distribution, some three days after her husband's death, she will receive from his kinsmen a ritual payment, and a substantial one, for her tears; and at later ceremonial feasts she is given more payments for the subsequent services of mourning. It should also be kept in mind that, to the natives, mourning is but a link in the lifelong chain of reciprocities between husband and wife and between their respective families.

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[3] Examples of scientific opinions, which ascribe to primitive law in general such a semi-religious character, are given in the review entitled "Primitive Law," referred to above.

THE LAW OF MARRIAGE.

This brings us to the subject of marriage, extremely important for the understanding of native law. Marriage establishes not merely a bond between husband and wife, but it also imposes a standing relation of mutuality between the man and the wife's family, especially her brother. A woman and her brother are bound to each other by characteristic and highly important ties of kinship. In a Trobriand family a female must always remain under the special guardianship of one man—one of her brothers or, if she has none, her nearest maternal kinsman. She has to obey him and fulfil a number of duties, while he looks after her welfare and provides for her economically even after she is married.

The brother becomes the natural warden of her children, who therefore have to regard him and not their father as the legal head of the family. He in turn has to look after them, and he has to supply the household with a considerable proportion of its food. This is the more burdensome since marriage being patrilocal, the girl has moved away to her husband's community, so that every time at harvest there is a general economic *chassé-croisé* all over the district.

After the crops are taken out, the yams are classified and the pick of the crop from each garden is put into a conical heap. The main heap in each garden-plot is always for the sister's household. The sole purpose of all the skill and labour devoted to this display of food is the satisfaction of the gardener's ambition. The whole community, nay, the whole district, will see the garden produce, comment upon it, criticise, or praise. A big heap proclaims, in the words of my informant: "Look what I have done for my sister and her family. I am a good gardener and my nearest relatives, my sister and her children, will never suffer for want of food" After a few days the heap is dismantled, the yams carried in baskets to the sister's village, where they are put up into exactly the same shape in front of the yamhouse of the sister's husband; there again the members of the community will see the heap and admire it. This whole ceremonial side of the transaction has a binding force which we know already. The display, the comparisons, the public assessment impose a definite psychological constraint upon the giver—they satisfy and reward him, when successful work enables him to give a generous gift, and they penalise and humiliate him for inefficiency, stinginess, or bad luck.

Besides ambition, reciprocity prevails in this transaction as everywhere else; at times, indeed, it steps in almost upon the heels of an act of fulfilment. First of all, the husband has to repay by definite periodic gifts every annual harvest contribution. Later on, when the children grow up, they will come directly under the authority of their maternal uncle; the boys will have to help him, to assist him in everything, to contribute a definite quota to all the payments he has to make. His sister's daughters do but little for him directly, but indirectly, in a matrilineal society, they provide him with his heirs and descendants of two generations below.

Thus placing the harvest offerings within their sociological context, and taking a long view of the relationship, we see that every one of its transactions is justified as a link in the chain of mutualities. Yet taking it isolated, torn out of its setting, each transaction appears nonsensical, intolerably burdensome and, sociologically, meaningless, also no doubt "communistic"! What could be more economically absurd than this oblique distribution of garden produce, where every man works for his sister and has to rely in turn on his wife's brother, where more time and energy is apparently wasted on display, on show, on the shifting of the goods, than on real work ? Yet a closer analysis shows that some of these apparently unnecessary actions are powerful economic incentives, that others supply the legal binding force, while others again are the direct result of native kinship ideas. It is also clear that we can understand the legal aspect of such relations only if we look upon them integrally without over-emphasising any one link in the chain of reciprocal duties.

The real reason why all these economic obligations are normally kept, and kept very scrupulously, is that failure to comply places a man in an intolerable position, while slackness in fulfilment covers him with opprobrium. The honourable citizen is bound to carry out his duties, though his submission is not due to any instinct or intuitive impulse or mysterious 'group-sentiment,' but to the detailed and elaborate working of a system, in which every act has its own place and must be performed without fail. Though no native, however intelligent, can formulate this state of affairs in a general, abstract manner, or present it as a sociological theory, yet every one is well aware of its existence, and in each concrete case he can foresee the consequences.

THE RULES OF CUSTOM DEFINED AND CLASSIFIED.

If we designate the sum total of rules, conventions, and patterns of behaviour as the body of custom, there is no doubt that the native feels a strong respect for all of them, has a tendency to do what others do, what every one approves of, and, if not drawn or driven in another direction by his appetites or interests, will follow the biddings of custom, rather than any other course The force of habit, the awe of traditional command and a sentimental attachment to it, the desire to satisfy public opinion—all combine to make custom be obeyed for its own sake. In this the 'savages' do not differ from the members of any self-contained community with a limited horizon, whether this be an Eastern European ghetto, an Oxford college, or a Fundamentalist Middle West community. But love of tradition, conformism, and the sway of custom account but to a very partial extent for obedience to rules among dons, savages, peasants, or Junkers.

Limiting ourselves strictly to savages once more, there are among the Trobrianders a number of traditional rules instructing the craftsman how to ply his trade. The inert and uncritical way in which these rules are obeyed is due to the general 'conformism of savages' as we might call it. But in the main these rules are followed because their practical utility is recognised by reason and testified by experience. Again, other injunctions of how to behave in associating with one's friends, relatives, superiors, equals, and so on, are obeyed because any deviation from them makes a man feel and look, in the eyes of others, ridiculous, clumsy, socially uncouth. These are the precepts of good manners, very developed in Melanesia and most strictly adhered to. There are further rules laying down the proceedings at games, sports, entertainments and festivities, rules which are the soul and substance of the amusement or pursuit and are kept because it is felt and recognised that any failure to 'play the game' spoils it—that is, when the game is really a game! In all this, it will be noted, there are no mental forces of inclination or of self-interest, or even inertia, which would run counter to any rule and make its fulfilment a burden. It is quite as easy to follow the rule as not, and once you embark upon a sporting or pleasurable pursuit, you really can enjoy it only if you obey all its rules whether of art, manner, or game.

There are also norms pertaining to things sacred and important, the rules of magical rite, funerary pomp, or what not. These are primarily backed up by supernatural sanctions and by the strong feeling that sacred matters must not be tampered with. By an equally strong moral force are maintained certain rules of personal conduct towards near relatives, members of the household and others towards whom strong sentiments of friendship, loyalty, or devotion are felt, which back up the dictates of the social code.

This brief catalogue is not an attempt at a classification, but is mainly meant to indicate clearly that, besides the rules of law, there are several other types of norm and traditional commandment which are backed up by motives or forces, mainly psychological, in any case entirely different from those which are characteristic of law in that community. Thus, though in my survey attention has naturally been mainly focussed on the legal machinery, I was not intent on proving that all social rules are legal, but on the contrary, I wanted to show that the rules of law form but one well-defined category within the body of custom.

AN ANTHROPOLOGICAL DEFINITION OF LAW.

The rules of law stand out from the rest in that they are felt and regarded as the obligations of one person and the rightful claims of another. They are sanctioned not by a mere psychological motive, but by a definite social machinery of binding force, based, as we know, upon mutual dependence and realised in the equivalent arrangement of reciprocal services, as well as in the combination of such claims into strands of multiple relationship. The ceremonial manner in which most transactions are carried out, which entails public control and criticism, adds still more to their binding force.

We may therefore finally dismiss the view that 'group-sentiment' or 'collective responsibility' are the only or even the main force which ensures adhesion to custom and which makes it binding or legal. *Esprit de corps*, solidarity, pride in one's community and clan exist undoubtedly among the Melanesians—no social order could be maintained without them in any culture high or low. I only want to enter a caution against such exaggerated views as those of Rivers, Sidney Hartland, Durkheim, and others, which would make this unselfish, impersonal, unlimited group-loyalty the corner-stone of all social order in primitive cultures. The savage is neither an extreme 'collectivist' nor an intransigent 'individualist'—he is, like man in general, a mixture of both.

It results also from the account here given that primitive law does not consist exclusively or even mostly of negative injunctions, nor is all savage law criminal law.[4] So far we have met with positive commandments only, the breach of which is penalised but not punished, and the machinery of which can by no procrustean methods be stretched beyond the line which separates *civil* from *criminal* law. If we have to provide the rules described in these articles with some modern, hence necessarily inappropriate, label, they must be called the body of 'civil law' of the Trobriand Islanders.

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[4] Quotations of such opinions in modern anthropological literature and a criticism of them is given in the review entitled "Primitive Law," referred to above.

'Civil law,' the positive law governing all the phases of tribal life, consists then of a body of binding obligations, regarded as a right by one party and acknowledged as a duty by the other, kept in force by a specific mechanism of reciprocity and publicity, inherent in the structure of their society. These rules of civil law are elastic and possessing a certain latitude. They offer not only penalties for failure, but also premiums for an overdose of fulfilment. Their stringency is ensured through the rational appreciation of cause and effect by the natives, combined with a number of social and personal sentiments such as ambition, vanity, pride, desire of self-enhancement by display, and also attachment, friendship, devotion and loyalty to the kin.

It scarcely needs to be added that 'law' and 'legal phenomena,' as we have discovered, described, and defined them in a part of Melanesia, do not consist in any independent institutions. Law represents rather an aspect of their tribal life, one side of their structure, than any independent, self-contained social arrangements. Law dwells not in a special system of decrees, which foresee and define possible forms of non-fulfilment and provide appropriate barriers and remedies. Law is the specific result of the configuration of obligations, which makes it impossible for the native to shirk his responsibility without suffering for it in the future.

SPECIFIC LEGAL ARRANGEMENTS.

The rare quarrels which occur at times take the form of an exchange of public expostulation (*yakala*), in which the two parties assisted by friends and relatives meet, harangue one another, hurl and hurl back recriminations. Such litigation allows people to give vent to their feelings and shows the trend of public opinion, and thus it may be of assistance in settling disputes. Sometimes it seems, however, only to harden the litigants. In no case is there any definite sentence pronounced by a third party, and agreement is but seldom reached then and there. The *yakala* therefore is a special legal arrangement, but of small importance and not really touching the heart of legal constraint.

Some other specific legal mechanisms may also be mentioned here. One of them is the *kaytapaku*, the magical protection of property by means of conditional curses. When a man owns coco or areca palms in distant spots, where it is impossible to keep watch over them, he attaches a palm leaf to the trunk of the tree, an indication that a formula has been uttered, which automatically would bring down ailment on the thief. Another institution which has a legal side is the *kaytubutabu*, a form of magic performed over all the coconut trees of a community to bring about their fertility, as a rule in view of an approaching feast. Such magic entails a strict prohibition to gather the nuts or to partake of coconut, even when imported. A similar institution is the *gwara*.[5] A pole is planted on the reef, and this places a taboo on any export of certain valuable objects, exchanged ceremonially in the *kula*, while their importation on the contrary is encouraged. This is a sort of moratorium, stopping all payments, without any interference with the receipts, which also aims at an accumulation of valuable objects before a big ceremonial distribution. Another important legal feature is a sort of ceremonial contract, called *kayasa*.[6] Here the leader of an expedition, the master of a feast, or the *entrepreneur* in an industrial venture, gives a big ceremonial distribution. Those who participate in it and benefit by the bounty are under an obligation to assist the leader throughout the enterprise.

All these institutions, *kayasa*, *kaytapaku*, and *kaytubutabu*, entail special binding ties. But even they are not exclusively *legal*. It would be above all a great mistake to deal with the subject of law by a simple enumeration of these few arrangements, each of which subserves a special end and fulfils a very partial function. The main province of law is in the social mechanism which is to be found at the bottom of all the real obligations and covers a very vast portion of their custom, though by no means all of it, as we know.

CONCLUSION AND FORECAST.

I have dealt here only with one province of Melanesia, and the conclusions arrived at have naturally a limited range. These conclusions, however, are based on facts observed by a new method and regarded from a new point of view; so that they might stimulate other observers to take up a similar line of study in other parts of the world. With a wider and more elastic 'minimum definition' of law, there is no doubt that new legal phenomena of the same type as those found in N.W. Melanesia will be discovered. There is no doubt that custom is not based only on a universal, undifferentiated, ubiquitous force, this mental inertia, though this unquestionably exists and adds its quota to other constraint. There must be in all societies a class of rules too practical to be backed up by religious sanctions, too burdensome to be left to mere goodwill, too personally vital to individuals to be enforced by any abstract agency. This is the domain of legal rules, and I venture to foretell that reciprocity, systematic incidence, publicity and ambition will be found to be the main factors in the binding machinery of primitive law.

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[5] Comp. the account of this institution in "Argonauts of the Western Pacific" (references in Index s.v. *Gwara*), also descriptions in Prof. Seligman's "Melanesians," and in the present writer's "The Natives of Mailu" (*Trans. R. Soc. of S. Australia*, vol. 39), of the *gola* or *gora* among the Western Papuo-Melanesians.

[6] "Argonauts of the Western Pacific." See in Index s.v. *Kayasa*.

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Our Bookshelf

Man in the Past.

Les origines de l'humanité. Par Prof. René Verneau. (Bibliothèque générale illustrée, 1.) Pp. 80+59 planches. (Paris: F. Rieder et Cie, 1926.) 15 francs.

To summarise adequately and in popular language the present position of our knowledge of the origin and development of mankind in a compass of less than eighty pages of not very small type, is a feat which is possible only to a master of his subject with a gift of lucid exposition such as Prof. Verneau. In this little book the uninstructed reader will find all that is essential for a thorough understanding of the elements of his subject and the bearing upon it of the geological and palæontological evidence. Nor has the author hesitated to deal with matters on which the views of experts differ. Even such questions as the antiquity of the Calaveras skull and the theories of Ameghino on the antiquity of man in South America are briefly discussed and the points at issue set forth. On the question of Neanderthal man, Prof. Verneau gives a succinct and carefully argued summary of the evidence upon which is based his own view that Neanderthal man is not an aberrant and extinct form, but stands in the direct line of descent as evidenced by atavistic types such as the Australian. Prof. Verneau's exposition is greatly helped by a very full series of remarkably well produced illustrations which alone would make this little book a possession to be desired by any archæologist.

Prehistoric and Roman Wales. By Dr. R. E. M. Wheeler. Pp. 229. (Oxford: Clarendon Press; London: Oxford University Press, 1925.) 18*s.* net.

Wales is a country which presents many difficulties and many pitfalls to the student of prehistory. The evidence is often scanty and sometimes, when considered in relation to the succession of cultural periods elsewhere, entirely lacking; and both in its character and in its distribution it is frequently puzzling to interpret. In the present volume, Dr. Wheeler has essayed to weave a connected story out of this material and, within the limitations imposed by the nature of his data, he has been eminently successful. His views are sane and cautious, but at the same time inspired with an imagination which is kept under careful restraint by a keen appreciation of how far his facts are capable of carrying the proof of any suggested conclusions. As an example may be cited the skilful use of probable climatic and geographical conditions in explaining the character and distribution of the palæolithic implement in Wales, the emergence of the area as a meeting place of culture from east and west, and its final transformation into a true frontier province under the Empire. His word of caution in regard to the, perhaps, too exuberant plotting of prehistoric trade routes is timely as well as characteristic. Amid so much that is excellent, a special commendation of the valuable summary and analysis of our present knowledge of Roman Wales may not be out of place.

Mystery Cities: Exploration and Adventure in Lubaantun. By Thomas Gann. Pp. 252+32 plates. (London: Gerald Duckworth and Co., Ltd., 1925.) 21*s.* net.

Dr. Gann is well known as an explorer in the realms of Central American archæology, and needs no introduction. Those who have read his "In an Unknown Land" can have no doubt of his ability to describe his adventures in pursuit of scientific data with a graphic power and a humour which endear him to the hearts of his readers, while giving a sufficient account of his results to make his book of permanent value as a record. He here describes his journey of the season 1924–25 in British Honduras, first to explore mounds at Xunantunich and afterwards to Lubaantun, where he joined Lady Brown and Mr. Mitchell-Hedges, his fellow-concessionaires, and continued the work of a preceding preliminary reconnaissance.

One of the results of the journey, as is well known, was the discovery of the remarkable amphitheatre which has no parallel in the whole area once occupied by the Maya. It provided seating accommodation for at least 5000 people "or at a pinch possibly 10,000," and measures approximately 350 feet from east to west by 300 feet from north to south, the greater part of the space being taken up by seating and standing accommodation for the spectators of whatever was taking place in the arena. There is a pathetic interest in turning from Dr. Gann's description of the monuments of the ancient Maya to his account of their degenerate descendants of to-day, to whom he does more than justice

Aspects of Psychology.

(1) *Education as the Psychologist Sees It.* By Prof. W. B. Pillsbury. Pp. ix+342. (New York: The Macmillan Co., 1925.) 8*s.* 6*d.* net.

(2) *Old and New Viewpoints in Psychology.* By Prof. Knight Dunlap. Pp. 166. (London: Henry Kimpton, 1925.) 10*s.* 6*d.* net.

(1) Prof. Pillsbury aims at presenting a concise summary of the problems of the teacher as they appear to the psychologist. The first part deals with the statistical side of psychological research and the nature of intelligence. Then follows an account of the general psychological processes and laws helpful to the teacher, namely, instinct, habit, attention, reasoning. A chapter is devoted to feeling and emotion in relation to discipline. At the end of each chapter is a list of questions.

To the teacher with a good psychological training the book is a useful synopsis of much scattered work, but to the beginner and to the general reader, to whom the writer also wishes to appeal, it may give the entirely illusory idea that much more is known than is actually the case. There is little indication of what is hypothesis and what is theory. The interpolation of physiological details—for example, the synaptic hypothesis, to explain associated acts—does not elucidate psychological occurrences. The account of correlation is of little value to any one who already knows it and inadequate as a first introduction. If it is necessary to introduce the Freudian theories at all, then more space should have been devoted to them; casual criticism, with no indication of the data for criticism, is out of place in an elementary book. The difference between suppression and repression is not made clear.

Although somewhat stereotyped, parts of the text are interesting. Its defects are largely due to its note form.

(2) Prof. Dunlap has brought together a number of papers given by him to various societies, and, as might be expected, they are of unequal value. The first chapter, on mental measurement, is the best, being a very able review of current work on the subject. The author gives an account of the work leading up to the present-day intelligence tests; he describes the aims and methods of the tests, discusses the claims legitimate and illegitimate of workers in this field, and issues a warning against the futility of many popular expositions.

The chapters on spiritualism and on the comic are somewhat sketchy accounts of a vast field. Dr. McDougall's theory of laughter published in this journal in 1903 might help to elucidate some of the problems of the latter. The chapter on present-day schools of psychology enables the author to tilt at all the more outstanding current systems. Doubtless the most ardent Freudian would agree with the author that to "repress effectively" is the greatest asset a human individual can have: the trouble lies in the adverb attached.

As lectures they must have been very stimulating; whether they merit book form is doubtful.

Art and the Unconscious: a Psychological Approach to a Problem of Philosophy. By John M. Thorburn. Pp. xii+242. (London: Kegan Paul and Co., Ltd., 1925.) 10*s*. 6*d*. net.

Mr. Thorburn has attempted to discover how far the problems of art and the sources of its inspiration may be restated in the light of contemporary theories of the unconscious. He begins by considering a domain where we are all artists, namely, the dream life, and goes on to relate this to the problems of the nature and origin of the imagination, art and the archaic, the function of symbolism, etc. The range of subjects discussed is wide, comprising literature, architecture, painting, and music.

The author has derived much inspiration from the writings of Freud and Jung, but he does not therefore make the mistake of neglecting conscious processes in his enthusiasm for the unconscious. The book is a contribution to the interpretation of art, to philosophy, and to the psychology of the imagination. The style is not easy and in places is decidedly laboured, due obviously to the difficulty of the conceptions.

Medical Science.

Arteriosclerosis: a Summary View. By the late Rt. Hon. Sir T. Clifford Allbutt. Pp. viii+108. (London: Macmillan and Co., Ltd., 1925.) 5*s*. net.

Intended for the busy practitioner, this summary of a larger work contains added material which makes the essay an admirable statement of the present state of knowledge of the subject. Sir Humphry Rolleston, who saw the little work through the press, reminds the reader of additions made by the author to the science and art of medicine. "Some of these are now so thoroughly incorporated in common knowledge and practice that our indebtedness in this respect is largely forgotten, such as the invention of the clinical thermometer now in use and the description of syphilitic disease of the cerebral arteries." His distinction between hyperpiesia, or high blood pressure of obscure origin, and the hyperpiesis of renal disease, which is in one sense the kernel of the essay, will also take its place in medicine surviving the elucidation of what is now obscure. For the light shed on the difficult problems of arterial disease and its consequences the volume will have many readers. It deserves a wider public for its amazing skill in the marshalling of hosts of facts and its delightful literary style.

Lister and his Achievement: being the First Lister Memorial Lecture delivered at the Royal College of Surgeons of England on May 14, 1925. By Sir Wm. Watson Cheyne. Pp. iv+136. (London: Longmans, Green and Co., 1925.) 7*s*. 6*d*. net.

The First Lister Memorial Lecture was a compression of a short history of Lister's work. Both are here printed together; the first occupies the opening thirty-eight pages of the volume and the second the remainder as an appendix. Without consideration of the necessity of such an arrangement if the lecture is to be given permanence in its original form, the plan is nevertheless not a perfect mode of presentation. At the same time no one who is genuinely interested in the development of surgery and in the life of its great English exponent would sacrifice any one of the glimpses which Sir Watson Cheyne has given of his great teacher. It may be said, however, that the earnest championship of the whole technique and nomenclature of Lord Lister's practice met with in these pages as against the newer 'improvements' is now receiving much more support than formerly from many surgeons, and we may still see a revival of *antiseptic* surgery.

Natural History.

(1) *The Monkeyfolk of South Africa.* By F. W. Fitzsimons. Second edition. Pp. xiv+172+48 plates. (London: Longmans, Green and Co., 1924.) 10*s*. 6*d*. net.

(2) *Chats on British Mammals: Ungulates, Carnivores, and Insectivores.* By Dr. Jas. J. Simpson. Pp. 122+4 plates. (London: The Sheldon Press; New York and Toronto: The Macmillan Co., 1924.) 2*s*. 6*d*. net.

(1) In his preface Mr. Fitzsimons says: "I am a strong advocate of books being written in simple language, because they are then easily comprehended

by learned men and women, as well as the most ignorant schoolboy or girl." That sentence may not be a model of tactful expression, but it shows consideration for the learned, and that, alas! is far from general. The author also says, very truly, that: "In the degree that a writer is able to interest the mind of the reader, so just in that degree will he succeed in impressing the cells of the grey matter of the brain. Unless the teacher succeed in arousing the intelligent interest of his pupil, he can make but little headway." There is, however, a right and a wrong way of doing this, and most certainly Mr. Fitzsimons has followed the latter. Apparently imagining it to be impossible to give a direct and at the same time an interesting account of the monkeys of South Africa and their habits, he has chosen to play the part of a talkative and most irritatingly well-informed monkey. Many a moralist, no doubt, has used such a device for the conveyance and gilding of his philosophic pills; but the naturalist should remember that he is dealing with lilies and refined gold.

(2) A glimpse of the right way to arouse and secure the "intelligent interest" of a pupil in his natural surroundings may be got from Dr. Simpson's "Chats on British Mammals," an early one of a series of little books containing the admirable "ten-minute" talks on natural history broadcast by the author from the Cardiff Station.

M. A. C. H.

Animal Life in the Sea. By R. J. Daniel. Pp. 119+4 plates. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd, 1925.) 5*s.* 6*d.* net.

Mr. Daniel gives a popular account of marine creatures from microscopic plants to fishes and whales, finishing with descriptions and explanations of various legendary sea serpents. It is a well-planned book, simply written, and will serve admirably for a first step towards interesting untrained observers in all that is to be found in the sea, the habits of the animals living in it, and the various phenomena connected with them, besides simple discussions of physical and chemical conditions from the surface to the depth of the ocean. The larger sea animals are most to the fore—fishes, whales, and giant cuttles—the illustrations being culled from many sources, including some from ancient maps and old pictures of sea monsters. Deep-sea animals are given special prominence, and the short account of conditions and life in the ocean depths is perhaps the best part of the book. In the small space of 117 pages an amount of interesting information has been included that might well have made a larger volume.

Concerning the Habits of Insects. By F. Balfour-Browne. Pp. x+169+9 plates. (London: Cambridge University Press, 1925.) 6*s.* net.

This small volume is the aftermath of the Christmas lectures, intended for a juvenile audience, which the author delivered at the Royal Institution in 1924. Its aim is to stimulate an interest in insect life and induce others to make observations in the wide field before them. In the first chapter the author utilises his own favourite studies of water-beetles as an example of what insect collecting may lead to. It is true that most of the real investigators in entomology were at one time in their lives collectors. There are also a great many folk who remain real collectors without ever becoming real entomologists. It is hoped that Mr. Balfour-Browne's book may lead to some depletion of the ranks of the latter class and, if so, retard the extinction of some of the more rare local insects.

In Chapter 2 the author describes his own delightfully simple and effective methods of observing the behaviour of some of the commoner solitary bees and wasps. The succeeding three chapters are devoted to phases of the habits of caterpillars, dragonflies, and water-beetles. All these accounts are written in a pleasing freshness of style, and there is no mistaking that the author has observed personally most of what he writes about. The book concludes with remarks on the economic significance of insects especially in relation to the transmission of tropical diseases. This apologia, as we may call it, for entomology winds up with an allusion to the possibility of a livelihood now being earned by its pursuit, although Mr. Balfour-Browne deplores any one taking up the subject with that intention.

A. D. I.

Notes on the Birds of Cley, Norfolk. By the late H. N. Pashley. Pp. 138+2 plates. (London: H. F. and G. Witherby, 1925.) 7*s.* 6*d.* net.

The late Mr. Pashley had the good fortune to live for many years on a part of the Norfolk coast which is almost unrivalled in the British Isles as a locality for rare migrants, and as a practising and well-known taxidermist he had great numbers of interesting specimens through his hands, in addition to the birds which he saw or obtained himself. The greater part of his small book—now published just after his death at the age of eighty-one years—consists of extracts from his ornithological diaries covering a period of thirty-eight years: this is a rich mine of information. There follows a systematic list in which the chief facts are conveniently summarised for each species. There are also a few pages of more general reminiscences.

One of the most interesting points which emerges relates to the changes which have taken place within the period covered. As Mr. B. B. Riviere says in his foreword, "The Shore-Lark and Lapland Bunting, which in the sixties and eighties respectively were regarded as very great rarities, are now regular winter visitors to Cley, the former in considerable numbers. The Black-tailed Godwit, no specimen of which appears to have found its way into Pashley's shop until the year 1917, has since then occurred regularly in the neighbourhood as an autumn, and occasional spring, migrant; whilst the Sandwich Tern, a rare passer-by of the eighties, now breeds in hundreds, almost within sight of Mr Pashley's windows." These are gratifying facts to set off against the depletion of our avifauna in so many other directions.

Zoological Handbooks.

Zoologisches Worterbuch. Von Dr. Erwin Hirsch-Schweigger. (Veit's Sammlung Wissenschaftlicher Wörterbücher.) Pp. viii+628. (Berlin und Leipzig: Walter de Gruyter und Co., 1925). 26 gold marks.

This short zoological dictionary is intended as a 'first aid' for professional zoologists, teachers, students, and amateur naturalists, its object being to provide a means of rapid orientation, without entering into minute details. The ground covered is not restricted to zoology in the narrow sense, but includes cytology, anatomy, genetics, and theoretical biology in general.

As regards systematic zoology, the higher subdivisions down to orders and the most typical families are well represented. Brief diagnoses of these are given, together with references to some of the genera and species. The value of these diagnoses and other definitions is enhanced by numerous cross-references. Some of the systematic groups are provided with index-numbers of the "Bibliotheca Zoologica," to which the reader is referred for further information. The geographical distribution of separate forms is indicated in a similar manner, the respective regions being arranged at the end of the book in tabular form. The classification adopted is also given at the end, side by side with that of the "Bibliotheca Zoologica." A useful feature of the dictionary is the accentuation of Latin and latinised words and the etymology of these and other foreign words, given in brackets.

In a book of this type it is perhaps inevitable that certain inaccuracies will occur. Thus the Aggregataria (or Aggregatidæ) are referred to the Gregarinida instead of to the Coccidia; the causative organism of tropical malaria is referred to as *Plasmodium præcox*, without mention of the name *P. falciparum*. The retention of Hartmann's artificial group Binucleata does not accord with the view of most protozoologists. The various members of the family Filariidæ, which actually belong to different genera, are all placed in one genus, Filaria. These minor defects do not detract from the general merit of the book, which may be recommended as a useful short guide to zoological nomenclature.

C. A. Hoare.

Animal Classification and Distribution, a Précis Reference Book for Students of Elementary Zoology at Secondary Schools, Colleges, and the Universities; being a Time-saving Synopsis with Provision for a Digest of Lecture Notes and Sketches. By Douglas M. Reid. (Griffin's Scientific Text-books.) Pp. xv + 51 (every other page blank). (London: Charles Griffin and Co., Ltd., 1925.) 6*s.* net.

The purpose of this volume is expressed in the opening lines of the preface: "Experience in teaching students of zoology has shown that many who are unfamiliar with the laws and principles of classification lose much time in searching various books to determine the position of some organism, . . . and to meet this need the present synopsis is provided." It must be said at once that the volume will require many emendations and additions if it is to enable the student to determine the position of the animals he sees or collects. A number of the small subdivisions containing relatively rare forms might well have been omitted and the space so obtained devoted to a fuller definition of the main groups. Many of the definitions contain loose statements which will lead to misunderstanding; *e.g.* "epithelium absent" is given as one of the characters of Nematoda (no doubt cœlomic epithelium was intended), and Gordius is said to be free living—a statement which takes little account of the life-history; the Zoantharia are defined as having a calcareous skeleton, but the example of the order correctly cited is Actinia, which has no skeleton. The author would do well to study page 9 and ask himself how the reader will know by inspection whether certain worms "have possessed chaetae," if in all Polychæta the "head end is fitted with tentacles"; if the posterior sucker of a leech is on the posterior segment, why the leeches alone among annelids are cited as exhibiting embryonic development; if Gephyrea are hermaphrodite (see Bonellia) and the mouth and anus are at the opposite ends of the body (see Sipunculus), and why the presence of a vascular system and nephridia are noted in Gephyrea but left unnoticed in Oligochæta and Polychæta, where they (especially the vascular system) are much more typical.

We do not feel able to recommend this volume as tending to a solution of the student's difficulties in classification.

Plant Morphology.

Monocotyledons: a Morphological Study. By Dr. Agnes Arber. (Cambridge Botanical Handbooks.) Pp. xv + 258. (Cambridge: At the University Press, 1925.) 21*s.* net.

Dr. Arber has produced a very clear, learned, and admirably illustrated treatise on the monocotyledons. To be properly appreciated it must be studied in detail, since it is a carefully reasoned morphological study dealing with the study of plant organs from the point of view of their internal structural features as well as of their external. Thus the root, the axis, the foliage leaf in its various forms as represented in the monocotyledons, and the prophyll, including phyllo-clades, are fully treated. The seedling and its interpretation is also discussed at length. In the chapter on the reproductive phase the floral peculiarities exhibited are described and details of the structure of the embryo sac and ovule are given.

This is followed by a discussion on taxonomy and a very interesting chapter on parallelism in evolution. The book concludes with a full bibliography and carefully prepared index.

Dr. Arber, though a disciple and fellow-worker of the late Miss Ethel Sargent, has largely followed her own ideas in writing this book and the result is a work full of fresh light on a fascinating problem—the meaning and interpretation, especially as regards their vegetative features, of the very diverse organisms which are grouped together in the phylum monocotyledons.

Many theories have been put forward to explain the relation of the monocotyledons to the dicotyledons, the most generally accepted being that the former have arisen from the latter. Dr. Arber, however, considers that the evidence, both from the living plants and the scanty fossil records, is not sufficient to warrant acceptance of such views. She would rather maintain that the great groups of flowering plants came independently into existence, and that their immense variety of form and structure at the present day is due to reduction, fusion and degeneration. Adaptation, she holds very strongly, affords no explanation of the characters which distinguish groups.

Both text and figures deserve the careful attention of botanists and students of evolution. The book is not only one for which the author deserves very high praise, but is also a production which reflects great credit on the Cambridge University Press.

An Introduction to Plant Anatomy. By Prof. Arthur J. Eames and Prof. Laurence H. MacDaniels. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Pp. xv+364. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 17*s.* 6*d.* net.

It is rare, indeed, that one meets a book that needs little but commendation, yet such is the case in connexion with this detailed text-book of plant anatomy. Without embarking upon general theories, the authors are merely concerned with the descriptive morphology of vascular plants. Physiological and ecological aspects of morphology, and the practical applications of this subject, are indicated incidentally to the general treatment, while comparative morphology is used only when it may help to make clear structural complexity. Although the treatment of the subject is in no way causal, yet the developmental side of morphology is well to the fore in chapters on meristems, the primary and secondary plant bodies, and in the treatment of cambial activities.

The view-point from which the organisation of the vascular tissues is developed is that these are primarily laid down on a cylindrical plan, from which various subordinate types can be traced. The treatment of this subject is as thoroughly up-to-date as the rest of the book. Lists of recent references are given at the end of each chapter, while excellent illustrations abound, notably those of different types of wood, presented by the courtesy of the United States Forest Service. The result is a well-balanced book which can scarcely fail to be of value to any botanist who uses morphological data.

Geology.

(1) *Mineralogie.* Von Prof. Dr. R. Brauns. (Sammlung Göschen, Band 29.) Sechste verbesserte Auflage. Pp. 143. 1·25 gold marks.

(2) *Geschichte der Geologie.* Von Prof. Dr. K. Hummel. (Sammlung Goschen, Band 899.) Pp. 123. 1·25 gold marks.

(Berlin und Leipzig: Walter de Gruyter und Co., 1925.)

These are recent issues of this excellent series which has been employed in Great Britain for practice in reading scientific German. The first (1) is a miniature text-book of mineralogy quite sufficient to give a sound elementary knowledge of the subject. It will be all the more welcome in Britain that Naumann's notation of crystal faces is discarded and only those of Weiss and Miller are placed before the student. The second (2) is a remarkably full but concise description of the historical development of geological science in all its branches.

Gestaltungsgeschichte der Erde. Von Dr. Leopold Kohn. (Sammlung Bornträger, Band 7.) Pp. vii+200. (Berlin: Gebr. Borntrāger, 1925.) 7·50 gold marks.

This is a readable but somewhat discursive account of the problems presented by the history of the earth. Special attention is given to the geosynclinal theory of mountain formation, which in one form or another has gained considerable support in recent years, though it has not obtained the approval of Prof. Heim. On this and other subjects the opinions of different authors are freely quoted. Altogether it is a stimulating book, and if it is somewhat inconclusive, that is largely to be attributed to the difficulties inherent in many of the questions with which it deals. A folder is included, giving a synopsis of the different stages in the earth's history.

Popular Astronomy.

A Popular Guide to the Heavens: a Series of Eighty-six Plates; with Explanatory Text and Index. By Sir Robert Stawell Ball. Fourth edition, completely revised and edited by the Rev. T. E. R. Phillips. Pp. xii+84+86 plates+13. (London: George Philip and Son, Ltd.; Liverpool: Philip, Son and Nephew, Ltd., 1925.) 15*s.* net.

After an interval of fifteen years since the publication of the third edition, this book now appears rehabilitated under Mr. Phillips's able revision. To the usual planetary diagrams, numerous lunar and stellar charts, drawings of planets and comets, a number of photographs have been added to represent the work of modern astronomical photography, together with a concise summary of such topics as methods of measuring the distances of the stars, the classification of stellar spectra, and new information on variable stars.

It is to be regretted, however, that sunspots—a source of interest to many people possessing small telescopes—are not represented by a short series of photographs, illustrating, for example, the growth of a typical stream of spots. The single plate portraying sunspots by direct photography is, we think, unwisely retained from the last edition to the exclusion of more recent and better photographs. The Stonyhurst charts might also have been mentioned as being very useful to the amateur.

It can be said with confidence that every one interested in astronomy, whether possessing a telescope or not, will be well equipped with this popular guide—a title which deservedly expresses its purpose in the fullest sense.

A Voyage in Space: a Course of Six Lectures "Adapted to a Juvenile Auditory" delivered at the Royal Institution at Xmas 1913. By Prof. H. H. Turner. Second edition, with an Addendum on Recent Discoveries. Pp. xvi+344. (London: The Sheldon Press; New York and Toronto: The Macmillan Co., 1925.) 7*s.* 6*d.* net.

The first edition of this book was published during the unsettled times of 1915. The publication of a second edition comes, therefore, as a welcome reminder of these excellent lectures, which being reproduced in print are made accessible to an increasing number of hearers beyond the limits of the lecture room. To those who have heard one of Prof. Turner's discourses on astronomy, the book will require no further introduction. To others, a hearty invitation may be given to share in the good things provided for the young people (and their seniors) at the Royal Institution. A glance at the numerous illustrations, averaging at least one to every three pages of text, will show the original, simple, and often amusing manner in which the author characteristically presents his subject to his audience.

The first three lectures are concerned with the preparations for the journey: (1) The starting-point, our earth; (2) the length of our voyage and the start through the air; (3) journeying by telescope. The remaining lectures are devoted to the journey itself: (4) visit to the moon and planets; (5) visit to the sun; (6) visit to the stars. During the interval of ten years between the publication of the two editions, the great advances of astronomy call for the addendum. In forty pages it is only possible, as the author says, to give samples of these advances. Nevertheless, the reader is introduced to things appertaining to relativity, the study of the upper air, recent ideas on stellar evolution, and the measurement of the diameter of α Orionis.

Mathematics.

Nouveau traité de mathématiques générales. Par Prof. Eugène Fabry. Tome 2. Analyse: Intégrales, équations différentielles, dérivées partielles, courbure, séries trigonométriques; Mécanique: vecteurs, cinématique, statique, dynamique, résistance des matériaux; théorie des erreurs. Quatrième édition entièrement refondue. Pp. 276. (Paris: J. Hermann, 1925.) 40 francs.

PROF. FABRY's object in this volume is to give a working knowledge of elementary mathematical analysis, leading to some of its mechanical applications. In the first half, dealing with differentiation, integration, and differential equations, he sketches the more familiar processes of the calculus but generally omits any reference to the refinements which a pure mathematician now considers to be essential to the discussion. Thus the account of Fourier series covers six pages, in which it is shown how to evaluate the coefficients, and includes no mention of the validity of Fourier's expansion. Subject to such limitations, the section on analysis contains little that is actually wrong. In the compass of 120 pages the ground covered ranges from elementary calculus to partial differential equations and Stokes' theorem. A reader prepared to disregard the niceties of pure mathematics will often find that the brevity of Prof. Fabry's treatment adds interest to the topics discussed.

Passing to the second half of the book, the section on statics contains three pages about catenaries. Centres of gravity and moments of inertia are discussed more fully. In dynamics there are chapters dealing with the motion of a single particle and with that of a rigid body about an axis. The last two chapters are devoted to the resistance of materials and the theory of errors, and are followed by a collection of 276 formulæ.

Prof. Fabry's style is lucid throughout, and his treatment of the various subjects discussed is brief through his ignoration of mathematical subtleties, not through over-condensation. The book, now in its fourth edition, is of greater value to engineers using mathematics as a tool than to students: the latter will generally find the author's treatment to be inadequate.

W. E. H. B.

Modern Physics.

The Spectroscopy of X-rays. By Prof. Manne Siegbahn. Translated with the author's additions by Prof. George A. Lindsay. Pp. xii+287. (London: Oxford University Press, 1925.) 20*s.* net.

THIS is an excellent translation of Prof. Siegbahn's well-known book, and it will be widely appreciated. Prof. Siegbahn and his pupils have made the field of X-ray spectroscopy peculiarly their own, and no one is better qualified than the author to review the present position of the subject. The refinements in technique which he has introduced have led to a knowledge of X-ray spectra which approaches in accuracy that of optical spectra at no very recent date, and the imposing table at the end of the book giving the principal X-ray spectral lines is a revelation as to the extent of the field surveyed.

The book has been written throughout from the view-point of the experimental investigator. Discussions of the purely theoretical aspect have not been entered into, but just so much theory has been given as will illustrate the interest of the various experimental results. The matter has been most carefully and wisely chosen with this object in mind.

The subject naturally divides itself into two parts, dealing with technique and with the significance for atomic physics of X-ray spectra respectively. In the first part an account is given of the types of X-ray tube, of spectroscopic apparatus, and of sources of high-tension current. Here will be found many useful hints, tables of the properties of materials, and a mass of information collected and arranged. The second part describes the laws of excitation of the spectra, the *K*, *L*, *M*, and *N* series, absorption spectra, the systematic arrangement of the spectral lines and its interpretation. The last chapter gives an account of the methods, other than those of wave-length measurement, which provide a means of measuring the inner energy levels of the atom.

X-ray spectroscopy is making such rapid advances that any review of it will need constant revision. One feels very grateful to the author for having found time, in the midst of his investigations, to collect the information, and present it in an attractive and convenient form. His book is an excellent introduction to the subject and review of the present state of knowledge, and is in a form which will make it possible to bring it up-to-date in future editions. Prof. G. H. Lindsay has worked in the author's laboratory, and his translation does full justice to the simple and readable style of the original book.

A Treatise on Electricity. By F. B. Pidduck. Second edition. Pp. xiv+664. (Cambridge: At the University Press, 1925.) 21*s.* net.

THE first edition of Mr. Pidduck's valuable treatise on electricity appeared in 1916, and the important advances made in the science during the past ten years have necessitated some changes in the present edition. In the earlier part of the book the most important alteration is to be found in the mathematical introduction, the vectorial methods and notation now employed resulting in considerable improvement in the subsequent mathematical analysis. The author, however, is on his guard against abandoning Cartesian analysis for a complete symbolic calculus, and his treatment should appeal to the physicist.

In the later chapters modern work has been described in considerable detail, though the treatment of recent theories of magnetism is somewhat slight. The chapter on electric oscillations is of great interest, and we find here scientific accounts of the triode as generator, detector, and amplifier, and also a description of its use for the production of short waves having a wave-length of only 30 or 40 cm. In the chapter on electricity in gases we have an account of the nuclear theory of the atom, and the results of Aston on the composite nature of the chemical elements obtained by means of his mass spectrograph. A separate chapter has been assigned to Röntgen rays, in which is given a compact but readable summary of the diffraction of the rays by crystals and of the nature and origin of the X-ray spectra of the elements. The last chapter deals with the electrical theory of matter, including Bohr's theory of the origin of spectra, the experiments of Gerlach and Stern showing definite orientation of electron orbits in a magnetic field, and the theories of the Zeeman and the Stark effect. In its revised form this treatise should prove of great assistance to the student of advanced physics.

The Dynamical Theory of Sound. By Dr. Horace Lamb. Second edition. Pp. viii + 307. (London: Edward Arnold and Co., 1925.) 18*s.* net.

The lucidity which characterises all Prof. Lamb's writings is exemplified in a marked degree in his treatise on the dynamical theory of sound. In this respect he follows in the footsteps of his master, Lord Rayleigh, to whom he acknowledges his indebtedness. For the second edition a thorough revision has been carried out, and a number of errors have been corrected. In its new form, the book should be of the greatest value to a student beginning the serious study of the subject. It is, however, to be regretted that the accounts given of recent applications are somewhat slight. Many readers would have welcomed more detailed descriptions of the hot-wire microphone, the methods employed in sound-ranging, and the problems of physiological acoustics.

Colloid Chemistry.

The Effects of Ions in Colloidal Systems. By Prof. Leonor Michaelis. Pp. 108. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1925.) 12*s.* 6*d.* net.

The author of this volume, who is a professor of biochemistry in Japan, was invited to lecture in the United States during April and May 1924. The material of these lectures is now presented as a brief monograph. In the introductory lecture, a defence is made of the pursuit by a biochemist of a line of research in pure physical chemistry. Such a defence is scarcely necessary, since it is a well-known phenomenon that a biologist with a genius for work in physical science, having a different range of interests and of relevant data from the professional physicist or chemist, can often make a contribution of exceptional value to the progress of pure science.

In the present instance the subject selected has been "The Effects of Ions in Colloidal Systems," and in a series of eight short lectures the author has presented in a most effective manner some of the principal problems that are encountered in this field of work, although he does not find himself able, in every case, to offer a complete solution. His chief interest appears to consist in the detection and study of "electric double layers," but one of the most interesting lectures deals with the properties of charcoal as an absorbent. This familiar material, instead of being a typical absorbent, as is generally supposed, appears to be unique amongst inanimate systems, since "experience has shown that *any* substance dissolved in an excess of water is adsorbed by charcoal," which "possesses a prominent faculty for adsorbing . . . non-ionised electro-indifferent substances."

The author introduces the term "acidoid" to describe substances such as mastic which have the properties of insoluble acids, whilst insoluble amino-acids are described as "ampholytoids." Fortunately, he has not yet begun to describe silver iodide as an "electrolytoid" in order to emphasise the fact that it is almost insoluble in water, but this will doubtless follow in due course.

English readers will be interested in the book, but will regard its price as excessive.

Introduction à l'étude des colloïdes : état colloïdal et ses applications. Par Prof. W. Kopaczewski. Pp. vii + 226 + 2 planches. (Paris: Gauthier-Villars et Cie, 1925.) 16 francs.

The first 64 pages of this small work profess to give the principal facts about the colloidal state, "all hypotheses and theories . . . being passed over in silence," while the remainder is divided into two parts, dealing with its industrial applications and with the colloidal state and life. This ratio of space, which is to be found in some other recent publications and appears to be becoming specific to the subject, seems a little difficult to justify; if it is granted, the author may be said to have done his work well. Although the industrial applications cover an immense field—cellulose and its esters, artificial silk, glue and gelatin, soil, beer, are among the sub-headings—he succeeds remarkably well, on the whole, in showing how the progress of colloid chemistry has thrown light on empirical procedure, or has led directly to the invention of new processes.

In the part devoted to the phenomena of life, inordinate space is given to the work of Leduc, which, fascinating as some of the experimental results are, can scarcely be considered seriously as throwing light on what goes on in organisms. The author is a medical man, and this explains the somewhat extended treatment of subjects for which the general reader is not prepared, like anaphylactic shock; whether a book of the present kind is the place for a somewhat surprising and emphatic condemnation of blood transfusion may also seem doubtful.

The book will no doubt give a number of readers the impression that 'there is something' in colloid chemistry, and may induce a few of them to seek something more than a mere bowing acquaintance with the discipline.

Chemical Analysis.

The Theory of Quantitative Analysis and its Practical Application. By Dr. Henry Bassett. (Twentieth-Century Chemistry Series.) Pp. viii + 308. (London: G. Routledge and Sons, Ltd., 1925.) 15*s.* net.

DR. BASSETT has produced a most interesting and valuable book. It is not a treatise on analysis; it is rather an exposition of modern ideas in physical chemistry, copiously illustrated by reference to detailed accounts of good analytical methods. For example, the chapter on the solubility product treats of various silver-halogen titration methods, and the determination of barium as sulphate. In connexion with co-ordination and complex ions, one finds a number of nickel-cobalt separations and the ammonium phosphomolybdate precipitation. Colloids, amphoteric compounds, electro-affinity, the composition of aqueous ammonia—such are a few of the other chapter headings.

The work is useful to the student and to the analyst alike. A careful perusal should help materially towards a knowledge of modern concepts of physical chemistry, while the criticism from a new point of view reveals the strength or weakness of the many analytical methods dealt with. A search for new methods should be assisted by an application of the principles set forth in the book, since in this way it may often be recognised at the outset that a suggested course of action is unsound and therefore not worth investigation.

The book is well produced, and very few typographical errors have been noticed. T. W. H.

Miscellaneous.

1825–1925: a Century of Stupendous Progress. By Joseph McCabe. Pp. viii + 168. (London: Watts and Co., 1925.) 5*s.* net.

MR. MCCABE presents in this very intriguing book a thesis involving two points: (*a*) "that there has been in the last one hundred years more progress in every respect than had ever been witnessed in five hundred years before, and (*b*) that this progress is due almost entirely to science." The author makes out a very strong case. Mr. McCabe is apparently moved to a defence of modern progress partly by the contributions of Bertrand Russell and Schiller in the "To-day and To-morrow" series issued by Messrs. Kegan Paul, Trench, Trubner and Co., Ltd., and partly by the persistence with which certain writers decry modern tendencies and belittle our times. Against such men the author expresses himself very vigorously. But after all this sort of cry has been common to all ages and civilisations.

However, whatever may be the promptings, Mr. McCabe has presented a very effective picture of life in 1825 at all angles in contrast with the conditions of to-day, and in the latter portion of his work he shows very forcibly the part science has played in this social and economic evolution. It may be argued that civilisation reached heights in the past in every way comparable with those of to-day, but there is much in the author's contention that a culture which did not reach or touch the common people cannot be counted as a general influence. It is from this point of view that Mr. McCabe's case derives its main strength: "From the world of the Middle Ages no reform could be expected. The five per cent. of Europe who could read and think were precisely those who profited most by the existing order of things; the ninety-five per cent., the mass of the workers, lived at so low an intellectual level that they hardly ever dreamed of changes." We feel confident that this stimulating book will find a ready public. L. B. H.

Meteorological Office: Air Ministry. British Rainfall, 1924. The Sixty-fourth Annual Volume of the British Rainfall Organisation. (M.O. 275.) Pp. xv + 266. (London: H.M. Stationery Office, 1925.) 15*s.* net.

THIS work maintains the same high order which has characterised its predecessors, although the superintendency of the British Rainfall Organisation has again changed hands, Mr. R. Corless now being responsible. In addition to the general table giving the rainfall of the individual observers at nearly 5000 stations, many details of considerable interest are given. Maps and tables show the distribution of rainfall in each month and for the year, and its relation to the average. Discussions are given of heavy falls in short periods and of the number of days with rain, as well as of spells of dry and wet weather during the year. Records are given of evaporation and percolation through the soil.

For the British Isles generally, 1924 was the wettest year since 1903, and at many stations it was the wettest year on record. For the whole area the rainfall was 17 per cent. in excess of the normal; in 1903 the excess was 27 per cent. A local downpour of 9·4 inches occurred on August 18 at Cannington, Somerset, of which at least 8 inches fell in 5 hours; this unprecedented rainfall is discussed at length in a special article by Dr. Glasspoole. Details are also given of the widespread deluge in the great thunderstorm of May 31, floods being general in western and northern districts.

In each month from April to October the rainfall was above the average, which is the longest sequence of wet months since before 1881.

Statistics are given showing the relative dryness or wetness of each month or year in the series 1881 to 1924 for England and Wales, Scotland and Ireland separately, and for the British Isles as a whole.

C. H.

Chambers's Encyclopædia: a Dictionary of Universal Knowledge. New edition. Edited by Dr. David Patrick and William Geddie. Vol. 7: Manchester to Pennywort. Pp. iv + 855. (London and Edinburgh: W. and R. Chambers, Ltd.; Philadelphia: J. B. Lippincott Co., 1926.) 20*s.* net.

SEVEN out of ten volumes of this useful encyclopædia have now appeared. The present volume bears evidence of revision and correction up to last year, and some of the articles have been completely rewritten since the earlier editions. It is no mean feat to compress such subjects as mining into seven pages, music into five, or Norway into less than six, but it appears to be done successfully in this work without sacrificing essentials and yet keeping the articles in a readable form. There are several new coloured maps.

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The Source of Stellar Energy.[1]

By Prof. A. S. EDDINGTON, F.R.S.

IT is generally agreed that the gravitational energy released by contraction is quite insufficient to provide the heat squandered by the stars in radiation. The Helmholtz-Kelvin hypothesis of contraction leads to an age of the sun, and therefore of the solar system, which is much too low. Revision of Kelvin's calculation in the light of modern results does not materially alter his figures; the present position is that the contraction theory gives an age of the sun 46 million years, or 19 million years if we measure from the time when its photospheric temperature reached 3000°. Moreover, these figures are rather too high, because they make no allowance for energy retained in the sun as energy of ionisation, which substantially reduces the amount left available for radiation.

Physical and geological evidence seems to be conclusive that the age of the earth—reckoned from a period which by no means goes back to its beginnings as a planet—is much greater. The age of the older rocks found from their uranium-lead ratio is generally put at 1200 million years; lower estimates have been urged by Prof. Joly, but none low enough to save the contraction hypothesis. An extension of the Kelvin time-scale is also demanded by the evolution of the earth-moon system. On the astronomical side there is the evidence of the Cepheid variables; if δ Cephei has no supply of energy other than contraction, we can calculate the rate at which its density must be increasing and the consequent change of period of its pulsations. This turns out to be much greater than the observations will admit, and it is found that at least in the Cepheid stage, evolution is proceeding at not more than one-hundredth of the rate given by the contraction hypothesis. This argument, although primarily referring to the pulsatory theory, should apply also to rival theories which admit that the light-period is intrinsic in the star whether it is a period of vibration or rotation.

We seem to require a time-scale which will allow at least 10^{10} years for the age of the sun; certainly we cannot abate our demands below 10^9 years. It is necessary to look for a more prolific source of energy to maintain the heat of the sun and stars through this extended period. We can at once narrow down the field of search. *No source is of any avail unless it liberates heat in the deep interior of a star.* The crux of the problem is not merely the provision for surface radiation, but the maintenance of the star's internal heat which keeps the gravitating mass from collapsing. To keep the sun in its present condition of distension it is necessary to maintain within it a temperature-gradient climbing from 6000° at the surface to 40,000,000° at the centre; if the present gradient is not kept up the sun will contract and evolve prematurely. Clearly you cannot maintain a temperature-gradient by supplying heat at the bottom end. If this year the sun encountered a swarm of meteors which bombarded it with enough energy to furnish a year's supply of radiation, that would not add a year or even a day to the life of the sun; its internal readjustments would go on unaffected. All that would happen would be that the sun would give us twice the normal amount of radiation this year.

Since we cannot very well imagine an *extraneous* source of heat able to release itself at the centre of the star, the idea of a star picking up its energy as it goes along seems to be definitely ruled out. It follows that the star contains hidden within it the energy which has to last the rest of its life. But energy cannot be successfully hidden; it betrays itself because it has (or because it is) mass. Energy of 9×10^{20} ergs has a mass 1 gm., and this will count as part of the mass of the star determined by astronomical methods. Energy of $1{\cdot}8 \times 10^{54}$ ergs has a mass 2×10^{33} gm., which is the mass of the sun; consequently that is the sum total of the energy that the sun contains. How much of this is capable of being converted into radiation we do not know; but if it is all available, there is enough to maintain the sun's radiation at the present rate for 15 billion years. To put the argument in another form, the heat emitted by the sun each year has a mass of 120 billion tons; and if this loss of mass continued, there would be no mass left at the end of 15 billion years.

SUBATOMIC ENERGY.

This store of energy is, with insignificant exception, energy of constitution of the atoms and electrons; that is to say, subatomic energy. Granting that the Kelvin time-scale is inadequate, granting that our argument against extraneous sources of energy is valid, granting that the accepted view of the conservation of mass and energy is not erroneous, the source must be subatomic energy, for everything else has been eliminated. Most of the store is energy inherent in the constitution of the electrons and protons and cannot be set free unless they are annihilated. We have to suppose that a proton and electron run together, their electric charges cancel, and nothing is left but a splash in the ether which spreads out as an electromagnetic wave carrying off the energy. The possibility of this occurrence has long been a favourite speculation; for my own part, I first encountered it in Larmor's "Aether and Matter" (1900), where a vivid picture is drawn of the creation of a proton and electron by cutting the ether round a tube and giving it a permanent twist, and it is discreetly hinted that the tube might one day slip back. Whilst this is one alternative, a small—but perhaps sufficient—part of the store can be released by a less drastic process, namely, the transmutation of the elements. When a helium atom is formed out of protons and electrons, 0·8 per cent. of the mass, and therefore 0·8 per cent. of the energy, disappears. If this evolution of the elements is occurring in the stars, the energy so released might be the source we are looking for.

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[1] Last of a course of three lectures delivered at King's College (University of London) on March 5.

The conclusion that an appreciable part of the energy of protons and electrons can be released without destroying them is due to Dr. Aston's researches with the mass-spectrograph in 1920. He proved that the deviations of the chemical atomic weights from whole numbers was generally due to the elements being mixtures of isotopes, and that the weights of individual atoms approximate very closely to whole numbers in terms of $O=16$; but for the hydrogen atom the small but significant deviation was confirmed, the weight being 1·008 and not exactly 1. This shows that the proton when isolated as in hydrogen has mass 1·008, but when brought into close contiguity with electrons in the nuclei of helium or higher elements, it has a combining mass 1·000. The difference no doubt represents the ordinary decrease of electrostatic energy when positive and negative charges are brought near together; and by the usual electromagnetic laws the disappearing energy (and mass) is carried away as radiation. If then helium is being formed in the stars, a supply of radiant energy is being released possibly sufficient to maintain their heat; and although mass is being radiated away, the total number of protons and electrons remains undiminished. This hypothesis was rather favourably considered by Prof. J. Perrin and the writer in 1920, but subsequent consideration has at any rate not strengthened its probability.

The further steps of evolution of higher elements release much less energy proportionately, so that not more than about 1 per cent. of the total store can be released, and that only if the material consists initially of hydrogen. In most of the work on the radiative theory it has been unnecessary to assume any particular chemical constitution of the star, except for the one proviso that there is not an excessive proportion of hydrogen; hydrogen gives widely different results from all the other elements, so that, curiously enough, the isolated scrap of information which we possess as to the chemical composition of the stellar interior bears upon this important question. I do not think we can admit more than 10 per cent. of hydrogen even in the youngest stars; it would thus appear that the evolution of the elements is far advanced in the pre-stellar nebular stage. In that case not more than one-thousandth of the total subatomic energy is releasable by transmutation; and the life of the sun past and future is brought down to $1{\cdot}5 \times 10^{10}$ years—a period perhaps not inadequate, but leaving little to spare. If we want more than this we must accept the hypothesis of annihilation of protons and electrons. The question now being put to the stars is, which of the two alternatives—transmutation or annihilation of matter—is providing the main supply of stellar energy?

Until recently the problem of the source of stellar energy was only of importance in connexion with the time-scale, and there was no pressing need for a decision between scales of 10^{10} and 10^{13} years. In 1916, when I began the studies described in the two preceding lectures, a more intimate contact with the problem seemed imminent, since some assumption must be made as to the relative distribution of the source in different parts of the interior. This distribution could be calculated definitely according to the Kelvin theory; but that theory was already obsolescent and there was no interest in working out the problem on such a basis. Progress became possible when it was realised that, within reasonable limits, the distribution of the source had only a minor influence on the results, and the question could be relegated to the stage of second approximation which we were not yet ready to undertake. It was early in 1924 that the problem was raised acutely by the conclusion that the dwarf stars are still in the condition of a perfect gas, contrary to the then accepted theory of evolution. It became clear that any new theory of evolution must be closely bound up with the laws of subatomic energy.

THE PROBLEM OF EVOLUTION.

It is well known that there is a certain statistical locus—a curve on the magnitude-type diagram—towards which the stars tend to concentrate. It was a merit of the giant and dwarf theory of evolution that it indicated this locus as the track of evolution of an average star. Any arbitrary change in the rate of liberation of subatomic energy would cause the star to move to some other position on the track, and the laws of subatomic energy were therefore only concerned in determining the *rate of progress*, *i.e.* the time-scale. They did not determine the track. The new conclusion makes this explanation of the statistical locus untenable. An arbitrary change in the liberation of subatomic energy will make the dwarf stars move off the track; we have therefore to exclude such arbitrary changes; that is to say, we have to consider the laws governing the liberation of subatomic energy if we are to understand the statistical locus.

In particular, the close dependence which we have found between luminosity and mass excludes any evolution of faint stars from bright stars unless we can admit that the mass decreases considerably during the star's lifetime. Not only in the giant and dwarf theory, but also in the theory which preceded it, evolution from the bright stars of types B and A to the faint stars of type M along the dwarf series has been a fundamental assumption. To avoid a complete upheaval of these ideas, we must admit substantial decrease of mass, and therefore the annihilation of matter. From this point of view—the aspect which concerns astronomers most practically—the hypothesis of annihilation of matter is really the most conservative; that does not necessarily make it true, but it justifies us in discussing it very seriously.

It is possible that a star might change mass in other ways than by radiation, but these other changes are probably much smaller. With fair certainty we can set an upper limit to the amount of accretion by the stars from diffuse matter in space; this turns out to be much less than the loss by radiation. The escape of matter from the stars must also be much smaller. I calculate that the sun's chromosphere would have to move outwards continuously at 100 km. per sec. in order to carry away as much mass from the sun as escapes by radiation. Needless to say, such a material outflow would be detected by the Doppler effect. I think, therefore, that the rate of loss of mass by a star can be set equal to its radiation so that it is a known quantity (independent of our views of subatomic energy), and the only question is whether the lifetime is sufficient for this loss to be a determining factor in stellar evolution. If the lifetime continues until the loss exceeds 1 per cent., the protons and electrons must be disappearing.

I suppose that most physicists will regard the subject of subatomic energy as a field of airy speculation. That is not the way in which it presents itself to an astronomer. Once it is granted that a star is evolving much more slowly than on the contraction hypothesis, so that its outflow of energy is practically the amount liberated within it, the measurement of the output of subatomic energy is one of the commonest astronomical measurements—the measurement of the heat and light of a star. Naturally the astronomer is not content to go on with these measurements indefinitely without an attempt to arrange them in some sort of coherence, to find out how they correspond with the internal temperature and density or the age of the material. If the physicist had in his laboratory unknown sources of energy, the output of which he could measure and the physical conditions of which he could determine, he would not be so backward in speculating on the causes and laws of the phenomena. The astronomical study of subatomic energy is no whit less direct than this; and although our attempts to weave the observational results into order are as yet unsuccessful, the problem is no more speculative than any other induction from experiment.

EXHAUSTIBILITY OF THE SOURCE.

Let us now examine some of the difficulties in the observational data. Consider the following:

The sun liberates 2 *ergs per gm. per sec. against* 58 *ergs per gm. per sec. by Capella.*

The sun has 620 *times the density and* 3·7 *times the internal temperature of Capella.*

Surely if density and temperature have any effect at all on the liberation of subatomic energy they must stimulate it. Density in particular brings the ingredients for any process closer together. Yet the sun, with higher temperature and density, liberates less than Capella. I think the only answer is that the sun is getting worn out; that it has, in fact, moved on to the higher density and temperature in order to stimulate a failing supply. It is admittedly an older star. We have thus an important factor forced on us, namely, exhaustibility of the supply.

Now consider the two components of Capella: a single star divided into two parts, and in accordance with the mass-luminosity law the heavier component radiates and has radiated more ergs per gm. than the light component. Consequently it has used up more of its supply. Yet the more massive star, more exhausted, at lower density, and at lower temperature, still liberates more ergs per gm. than its companion.

It may be urged that if the fission occurred within the last 100,000 years the components have not yet reached the steady state; in that case it would not be fair to equate the release of subatomic energy to the observed radiation. But the case of Capella is typical of the spectroscopic binaries in general,[1] and these are so numerous that they cannot all be of so recent a date. In most *eclipsing variables*, however, the faint component is the cooler, and its lower output of energy would thus be explicable. These are stars in which the two components are very close together—sometimes almost touching—and their formation is probably recent. *It is just those stars in which (owing to recent formation) exceptional behaviour would be pardonable which require no excuse.*

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[1] Except that in the dwarf binaries there is no appreciable difference in the internal temperatures of the two components.

Jeans suggests that when fission occurred the heavier component would appropriate the central portion of the original star, where the heaviest elements containing the more active sources might be concentrated. To this there are two objections. First, so far as we can calculate, diffusion is unable to effect any appreciable separation of the light and heavy elements in the lifetime of a giant star. Secondly, the rotation of the star causes circulating currents which keep the material sufficiently stirred. This last conclusion rests on a theorem of Von Zeipel criticised by Jeans; but I am convinced that Von Zeipel is right. It is, therefore probable that when a star divides, the initial constitution of the two components is identical.

With regard to the latter point, some doubt may exist as to the efficiency of the stirring, owing to the likelihood that the circulation will become stratified. I understand that in a viscous liquid the vorticity has a tendency to break up into layers, so that the star might be divided into two or three shells with thorough mixing in each shell and not much mixing between successive shells. But even so I do not think that the general mixing would cease altogether. The diffusion which it has to counteract is exceedingly slow, and it would take at least 10^{13} years for the heaviest and lightest elements to separate. The age of Capella when it divided could not be much more than 10^{11} years. Moreover, although the heavy elements would tend to sink to the centre in small stars, the tendency in massive stars like Capella appears to be opposite. According to physical theory, the heaviest atoms have the highest absorption coefficients and experience the greatest radiation pressure. The interaction of the gravitational and electrical fields with radiation pressure leads to curious results; so that in Capella the heaviest elements together with hydrogen and helium would flow towards the surface, the other light elements tending towards the centre.

The Main Series.

Turn now to stars on the 'Main Series' which stretches from types O and B down the old dwarf series to type M. By far the majority of the stars are on this series, so that presumably it corresponds to the major part of a star's life. The giant stage appears to be a temporary halt during which a very active, but soon exhausted, supply of energy is being tapped; the star then goes on to the Main Series, where it remains until its chief supply is exhausted. At this stage, if at all, the energy is being derived from annihilation of protons and electrons, for the star cannot move along the Main Series unless it undergoes substantial loss of mass. We might expect the stars to continue in this stage until the end, since it is difficult to see why the protons and electrons should ever grow tired of destroying one another; apparently, however, some more refractory material is present (or is evolved) in the star, so that in some stars at least a residuum remains unburnt, which passes on to the fiercer ordeal of the 'White Dwarf' stage.

In the Main Series we find a simplicity in the laws of subatomic energy which is perhaps more embarrassing than the previous complications. As H. N. Russell has pointed out, all the stars in this stage have practically the same internal temperature. I find the central temperature on the Main Series to be 40 million degrees; Russell puts the figure rather lower.

The close uniformity of internal temperature is beautifully shown in a diagram for a considerable number of individual stars published by Russell (NATURE, August 8, 1925, vol. 116, p. 209). The following treatment may be considered supplementary to his. It is difficult to allow for the errors of observational data of individual stars and to know just how much stress should be laid on particular discordances. We propose therefore the converse problem:—Assuming a constant central temperature of 40,000,000° along the Main Series, we find the consequent relation between luminosity and spectral type and compare it with the relation indicated by the general stellar statistics.

RESULTS FOR ASSUMED CENTRAL TEMPERATURE 4×10^7.

Mass.	Bol. Mag.	Vis. Mag.	Eff. Temp.	Type.
0·182	11·94	14·5	2,550°	<Md
0·258	10·25	11·6	3,210	K9
0·512	7·26	7·6	4,540	K0
0·746	5·93	6·1	5,160	G4
1·00	4·47	4·5	6,290	F8
1·58	2·43	2·5	8,250	A8
2·56	0·52	0·9	10,520	A0
4·53	−1·38	−0·6	13,260	B7
11·46	−3·86	−2·4	17,460	B2
37·67	−6·44	−4·3	22,500	Oe
90·63	−8·12	−6	26,200	O

From the mass in the first column and the assumed central temperature we can deduce the bolometric magnitude and effective temperature by the radiative theory.[1] The reduction to visual magnitude is taken to correspond to the effective temperature. In the last column spectral types are assigned corresponding to the effective temperatures according to what I suppose to be the most generally accepted scale. Taking columns 3 and 5 of the above table, we obtain a magnitude-type relation which follows with great accuracy the central line of the Main Series as indicated by observational statistics. Without laying undue stress on the closeness of the accordance, we must conclude that the temperature in this phase of evolution is surprisingly steady.

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[1] In the first three lines of the table a small correction has been applied to the predicted bolometric magnitudes in order to bring them closer to the empirical mass-luminosity curve. (This correction is derived from data independent of the present type-luminosity comparison.)

Whether the star requires a supply of 680 ergs/gm. sec. like V Puppis, 2 ergs/gm. sec. like the sun, or 0·08 ergs/gm. sec. like Krueger 60, it has to rise to a temperature of about 40,000,000° to obtain it. Apparently at that critical temperature the supply is *ad libitum*. Can we suppose that energy issues freely from matter at 40,000,000° as steam issues from water at 100°? I think that physicists would be hard put to it to reconcile such extraordinary behaviour with any accepted principles, yet that is what the astronomical observations taken at face value seem to insist on.

OVERSTABILITY.

Here we encounter another difficulty depending on 'overstability.' Imagine a vertical cylinder with a piston, the chamber containing hot gas. To increase the resemblance to a star we must suppose that heat is continually being admitted into the chamber and an equal amount leaks away through the walls. The piston will rest in stable equilibrium on its cushion of hot gas, and if slightly displaced will return to its equilibrium position after small oscillations. But suppose that the piston operates a valve which admits extra heat to the chamber when the piston is lowered and shuts off the heat supply when the piston is raised. Then (allowing for the leakage) the chamber gains heat at the time of compression and loses heat at the time of rarefaction—just like the cylinder of any heat engine—consequently a slight displacement of the piston will set the engine working and the piston will move up and down with increasing amplitude. I call this 'steam-engine' condition *overstability*: it is not instability (a tendency to move away from equilibrium), but a tendency to return towards equilibrium with too much impetus so that oscillations increase instead of dying out. Now it will be seen that if there is a critical temperature, the oscillations of a star work a valve just in this way: If the star is compressed it becomes hotter; a larger region is raised above the critical temperature and more subatomic energy is released. If it expands, the centre falls below the critical temperature and the heat supply stops. Consequently the star begins performing like a steam-engine. If the power of the engine is only slight, it may be unable to overcome dissipative forces and the star will remain stable; but at least in the faint stars, which normally keep only a small region at the centre above the critical temperature, overstability will result. We know of some stars—the Cepheid Variables—which, whether from this cause or some other, are overstable and consequently pulsate, but they are uncommon, and they are all giant stars or stars at the head of the Main Series; they are, in fact, just the wrong stars to suit the theory.

I have referred to this difficulty of overstability primarily as an argument against too readily accepting the idea of a critical temperature at 40,000,000°, but it is also a general difficulty. The channel between the Scylla of instability and the Charybdis of overstability turns out to be so narrow that it is difficult to devise any law of subatomic energy which will steer the star safely through it. Tentatively I am inclined to cut the knot by introducing yet another complication. I suppose that a change of temperature or density does not immediately change the rate of liberation of energy; there is a time lag of months or perhaps hundreds of years, so that short-period changes have no effect. This would happen if temperature and density controlled the rate of formation of self-destroying material which afterwards proceeded to liberate its energy spontaneously at a rate unaffected by temperature and density.[4]

It will be seen that we have already encountered a number of difficulties. I daresay that we can wriggle out of these somehow, but that kind of procedure is not very convincing. I think that a successful theory ought occasionally to predict right results at the first attempt and not invariably to guess wrong, afterwards making amends by introducing a new complication. It looks as though we have not yet the right clue in our hands for a general synthesis of the problem of subatomic energy, and we are not prepared to advocate one theory in preference to another. We shall, however, continue here to glean what facts we can from the astronomical observations.

DEPENDENCE ON TEMPERATURE AND DENSITY.

By considering the stability of a star we can show that the rate of liberation of energy increases with temperature or density or with both. Let the rate of liberation of subatomic energy be E and the rate of radiation from the star be L. In a steady state $E = L$. Now suppose that E drops below L; the star contracts (as on the Kelvin hypothesis which postulates $E=0$). But it is generally agreed that L increases as the radius decreases, so that the deficit is made worse. Further contraction ensues, with further increase of L, and the star gradually collapses. To save the star we must suppose that the increase of temperature and density by the contraction causes an increase of E, so that E becomes greater than L and drives the star back to equilibrium. The threatened instability is not catastrophic, and the collapse would occupy a time comparable with the Kelvin time-scale; but of course we must provide against such a collapse since we reject the Kelvin time-scale.

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[4] If the annihilation of matter were due to free electrons shooting at the protons in the nucleus and destroying them by direct hits, the rate would be proportional to $\rho T^{-\frac{1}{2}}$ (subject to a dependence on the chemical composition if the protons in some nuclei are better protected than in others). As this law seems to have no support from observation, we conclude that it is not the free electrons but the bound or the nuclear electrons which perform the task. Hence arises the idea of formation of elements with a *penchant* for self-destruction.

In Jeans's theories the release of subatomic energy is supposed to be independent of the temperature and density (by analogy with ordinary radioactivity). This view is also taken by Nernst. I have felt constrained to reject it from the beginnings of the researches on radiative equilibrium, since it leaves no means by which E and L for the different stars can be brought to a balance. Prodigious changes of density are required to alter L by a factor of more than 3 or 4, and as stated in the last paragraph, the adjustment of L is most probably in the wrong direction. It seems essential that the adjustment should come about by changing E. It is true that theoretical physics opposes difficulties to the idea that stellar temperatures can appreciably affect subatomic processes; but they are difficulties which obviously must be surmounted. It has, for example, been objected that the temperature in the stars is not great enough for the transmutation of hydrogen into helium—so ruling out one possible source of energy. But helium exists, and it is not much use for the critic to urge that the stars are not hot enough for its formation unless he is prepared to show us a *hotter place*.

The assumption that E is independent of temperature and density gives a cast-iron rule into which there seems no hope of fitting the astronomical data. It requires that the energy per gram liberated and radiated by any star depends only on the age. What zero the age is to be reckoned from is not clear. In any case, study of coeval groups of stars such as the Pleiades, Hyades, Præsepe, etc., does not confirm this hypothesis.

EVIDENCE OF DECREASE OF MASS.

We now consider more particularly the theory that the mass of a star changes considerably during its evolution. As already explained, this requires the more drastic hypothesis of annihilation of electrons and protons, transmutation of the elements being unable to provide sufficient energy for the longer time-scale involved. There can be no evolution down the Main Series unless this change of mass is admitted; the star would presumably evolve rapidly until it reached the Main Series, remain unchanged for the greater part of its life, and then go on to the white dwarf stage. That means that evolution would cease to play a prominent part in astrophysics. The fact that the stars leaving the Main Series (white dwarfs) are generally of smaller mass than the stars approaching it (giants) is an argument in favour of considerable change of mass in this stage.

The statistics of giant stars also support this view. Assuming that the most diffuse condition is the earliest, the average mass of a star at or near birth can be found from the statistics of giant K and M stars. Determining the masses from the luminosities, we find that 90 per cent. of these young stars have masses between 2·4 and 5·5 × sun; whereas the average for the stars in general is less than that of the sun. This strongly suggests that most stars have lost a large part of their original mass. The result fits in well with the conclusion reached in the first lecture that the masses of the stars correspond to the critical range where radiation-pressure is gaining ascendancy. Taking the average of all the stars, say ½ to 1 × sun, radiation-pressure is between 0·007 and 0·05 of the whole pressure—clearly too low a value. But we ought rather to take the initial masses before there was any wastage; the masses 2·4–5·5 × sun give the proportion of radiation-pressure 0·17–0·35, which is just the range likely to be effective.

For this reason I conclude that stars are not usually born with mass less than 2 × sun. It might be argued that we do not observe diffuse stars of smaller mass because they condense very rapidly. But why? They are not exhausting their store of energy so fast, and ought to evolve more slowly.

COEVAL STARS IN CLUSTERS.

There is, however, an argument perhaps equally strong on the other side which we shall now try to explain. We first draw up a table showing the time taken for a star to evolve through a given range of mass or of luminosity. This can be done because $dM/dt = -L/c^2$, the mass of the outflowing radiation L ergs being L/c^2 gm. Since L can be expressed as a function of M by the mass-luminosity law, the equation can be integrated[5] to give M as a function of t

Mass (Sun = 1)	Abs. Bolometric Mag	Duration of Stage.
∞ to 35	< −5	·038 × 10^{11} years
35 „ 10	−5 to −2½	·065
10 „ 3·7	−2½ „ 0	214
3·7 „ 1·73	0 „ 2½	·93
1·73 „ 0·92	2½ „ 5	5·21
0·92 „ 0·53	5 „ 7½	36·3
0·53 „ 0·31	7½ „ 10	·281
0·31 „ 0·18	10 „ 12½	2190

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[5] *Monthly Notices, Roy. Astr. Soc.*, 84, p. 308.

The table applies primarily to the Main Series on which the internal temperature remains constant, but can also be used with sufficient approximation for the giant stars. We see that, however large the initial mass, there cannot be more than mass 2 left at the end of a billion years. Consequently, if a cluster contains stars of mass greater than 2, that is, brighter than about $+2^m$, the cluster cannot be more than a billion years old. But looking lower down the table we see that a billion years is quite insignificant for the evolution of the fainter stars; so that if the cluster also contains stars of magnitude 5^m to 7^m, these must have been born with practically the same mass and luminosity which they now possess. It is found that many clusters contain bright and faint stars together, and our argument shows that in this case the faint stars cannot have evolved appreciably. If we have to deny the evolution of dwarf stars in clusters, is there any point in assuming evolution of dwarf stars in general? In any case it looks as though we must abrogate the idea that the stars cannot be born with masses less than 2.

Yet, although the observations of clusters appear to contradict our conclusion, we take some courage from the fact that they do so rather half-heartedly. (It is such a novel experience to find Nature taking any notice of our predictions in regard to subatomic energy, that a half-hearted denial is a cause for elation.) I learn from Hertzsprung that moving clusters such as the Hyades, Pleiades, and Præsepe certainly do not contain anything like their full quota of faint dwarfs. They stop suddenly at about $+7^m$, with few or none fainter than this limit. There appears also to be evidence that in globular clusters the dwarfs are not nearly so numerous in comparison with the giants as in the galactic system generally. Perhaps, therefore, there may be something in our argument as to the difficulty of bright and faint stars existing together in coeval systems, though we clearly have not yet got it formulated quite aright.

In the galactic system, where it is presumed that we have to do with a mixture of stars of all ages, the number of stars in any stage should be proportional to the duration of the stage. Hence the figures in the last column of the table should be proportional to the number of stars between the corresponding limits of magnitude. This prediction, however, applies only to masses below 2; the numbers corresponding to the earlier part of the table must be greatly reduced, because most stars start from masses between 2 and 5. The luminosity distribution predicted in this way is fairly well confirmed by the observational statistics.

Another test which affords some slight support for the theory of evolution by loss of mass has been applied by Vogt. It is easily seen from the table that if two stars start with widely different masses, the ratio of the masses will approach equality as time goes on. Hence in double-star systems we should expect large mass-ratios only in the early stages of evolution, and the mass-ratio should progressively approach unity for the later spectral types. This appears to be satisfactorily confirmed.

It might perhaps have been hoped that the loss of mass, through its effect on the dynamics of double-star systems, would clear up some of the problems with regard to their separations and eccentricities hitherto unexplained. This has been investigated by Jeans and Smart; but the results are disappointing, and the new theory does not bring any illumination to the outstanding problems. Nor can I glean anything particularly favourable or unfavourable to the theory from the various other discussions which have appeared.

COMPTON EFFECT.

As illustrating the close connexion between the progress of pure physics and astronomy, we may note that the discovery of the Compton effect relieved what had been a real difficulty in regard to subatomic sources of stellar energy. By the quantum theory the radiation emitted in the formation of helium from hydrogen should be of wave-length 0·00041 Å.U., and in the annihilation of a proton and electron 0·000013 Å.U. By what mechanism can this high frequency radiation be transformed down to the ordinary forms of heat energy in a star? The usual absorption coefficients fall off as the cube of the wave-length, and the second of the above quanta would probably go right through the star—and to the end of the world—without finding anything to absorb it and turn it into utilisable heat. It would be scattered fairly often, because the coefficient of scattering by electrons, although decreasing for short wave-lengths, does not fall off so rapidly; but so long as it was thought that the wave-length was unaltered by scattering, that did not help to solve the difficulty. Now the theory of the Compton effect tells us that the wave-length is increased by $0·024 (1 - \cos \theta)$ Å.U. after scattering; so that, however short the original wave-length, the first appreciable scattering reduces the radiation to ordinary γ-ray status. Most of the energy passes into a recoil electron which flies off with enormous energy; and there is then no difficulty in seeing how the energy is frittered away into ordinary molecular heat.

PENETRATING RADIATION.

The question of the origin of the penetrating radiation found in the earth's atmosphere has considerable interest in connexion with subatomic energy. An astronomical turn was given to the problem a few years ago by Kohlhörster's experiments, which claimed to show that the radiation was travelling downwards and, therefore, presumably coming from outside our atmosphere. He found also that the intensity depended on the altitude of the Milky Way, so that most radiation was received when the greatest extension of the stellar system was overhead. The altitude of the sun made no difference, showing that the sun was not the source. The penetrating power was evidently much greater than that of any known γ-rays, so that it seemed clear that the radiation could only come from some powerful subatomic source such as the transmutation of hydrogen or the annihilation of matter. Very recently Millikan has announced the results of an extensive and careful study of this radiation. He is strongly convinced that it comes from extra-terrestrial sources; and he finds that the penetrating power agrees with that of the quantum emitted in the formation of helium from hydrogen.

Being unfamiliar with the technical details and difficulties of the experiments, I cannot take sides either with Kohlhörster and Millikan or with their critics. In the earlier days it had seemed to me that the high penetrating power (which seems to be universally admitted) went far to settle the question. This indicated a concentration of energy such as could only result from drastic subatomic processes; and it was at any rate less sensational to suppose that these processes were occurring in the depths of space than to postulate them on our own planet. But I was somewhat shaken by C. T. R. Wilson's calculations as to 'runaway' electrons in thunderstorms. He showed that these could acquire sufficient energy to furnish radiation of this nature without involving subatomic processes. It would, however, be difficult to account for the downward flow of the radiation if it were originated by Wilson's electrons.

If physicists ultimately are satisfied as to the extra-terrestrial origin of the radiation, what bearing will it have on the problems studied here? The chief conclusion to be drawn from it is that the subatomic processes can occur at comparatively low temperature—less than 100,000°. All the really hot matter of the universe is securely tucked away behind walls sufficiently thick to stop and scatter the most penetrating radiation; it cannot be the source of the radiation reaching us. Our choice lies between the photospheric layers of the stars and the nebulous matter in space. The latter origin is the more probable. Unless the stars are more potent sources than the sun, the penetrating radiation from the stars will be to that from the sun roughly in the proportion of starlight to sunlight; the experiments show that no appreciable part comes from the sun, and *a fortiori* that from the stars should be negligible. The diffuse and dark nebulæ and the matter scattered through interstellar space may perhaps amount to a total mass as great as the whole mass of the stars; and, moreover, there is no screening, so that all the radiation originating from it is able to reach us.

If this is right we must draw another important conclusion—the subatomic processes can occur at extremely low density. Astronomically we welcome these conclusions. We are hard put to it to explain the occurrence of helium and other elements in the nebulæ and of rather advanced elements in the spectra of the earliest stars, unless there is a building up of the higher elements in the pre-stellar stage of low temperature and density. But the physicist may well shake his head over the problem. How are the protons and electrons to meet and cancel one another in a medium so rare that the free path lasts for years? How are 4 protons and 2 electrons to assemble together and create a helium nucleus? It is perhaps a comfort that this last occurrence is so improbable under any conditions of density and temperature that we can postulate it in the nebulæ—on the principle that we may as well be hung for a sheep as a lamb. We recall also that these conclusions are in keeping with the observational fact (so difficult to reconcile with theory) that in general it is the diffuse low-temperature stars which liberate subatomic energy most prolifically.

I should have liked to close this course by leading up to some great climax. But perhaps it is more in accordance with the conditions of scientific progress that it should fizzle out, ending with a glimpse of the obscurity which marks the frontiers of present knowledge. I do not apologise for the lameness of my conclusion, for it is not a conclusion. I wish I could feel confident that it is even a beginning.

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Supplement to NATURE

No. 2952 MAY 29, 1926

Electrons, Atoms and Molecules.[1]

By Prof. T. M. Lowry, F.R.S.

Any one who is familiar with the state of chemistry before and after the War must recognise that, whilst chemical practice and chemical beliefs have undergone very little alteration, the foundation underlying these beliefs has been altered profoundly by recent physical discoveries. In particular, although chemists still believe in Dalton's atoms and in the molecules of Avogadro, they have been compelled to accept an entirely different picture of the structure of the atom, and to adopt a new and revolutionary conception of the nature of the forces which bind the atoms together into molecules. Whilst, therefore, chemical research still proceeds along familiar paths, and is expressed by means of familiar terms and symbols, physical research has given us a new outlook; and, since what a man does is ultimately determined by what he believes, it is certain that chemical practice as well as chemical theory must be influenced profoundly by the new ideas that have been given to us by our physical colleagues. The object of this discourse is to indicate some of the aspects of pre-War chemistry which have been transformed by the impact of post-War physics.

MOLECULAR DIMENSIONS.

The principal contribution of the physicist to our knowledge of molecules has been a numerical one. He has taught us how to count, to weigh, and to measure individual molecules, and, in the person of Sir William Bragg, he has provided us with a convenient system of units in which to express these quantities. This system is based upon Ångström's unit of length, 10^{-8} cm., which has long been used in order to express the wave-lengths of light of different colours. Bragg has, therefore, proposed[2] to measure areas and volumes in 10^{-16} sq. cm. and 10^{-24} c.c.; and although it is scarcely possible to picture the process of filling with water a vessel with a capacity of only 10^{-24} c.c., it is, nevertheless, an obvious step to make the unit of mass correspond with the unit of volume, as 10^{-24} gram.

Having got a suitable system of units, we can use them in order to express atomic and molecular dimensions. The fundamental constant in this investigation is the *Avogadro number*, which tells us the actual number of atoms in the gram-atom of any element, or of molecules in the gram-molecule of any element or compound. Unlike Loschmidt's number (which tells us how many molecules there are in 1 c.c. of a gas at normal temperature and pressure), this is a universal constant, since it is not influenced by deviations from the ideal gas laws. During the past twenty years, more than a score of attempts have been made to determine the numerical value of this constant, by the most diverse methods; but I need only quote the number finally deduced by Millikan in 1917 from a study of the movement of a rain of electrified oil-drops. This curiously indirect method has given surprisingly accurate results; indeed, it is said that the number of molecules in a gram-molecule of a pure substance is known with about the same degree of accuracy as the total population recorded in the census of a big city such as Chicago. In conformity with our scheme, Millikan's value of the Avogadro constant can be expressed most conveniently in powers of eight as $N = 0{\cdot}6062 \times 10^{24}$.

By taking the reciprocal of this number we can deduce at once that *the weight of an individual atom or molecule in Ångström units is* 1·65 *times its atomic or molecular weight*. For example, the mass of an atom of hydrogen is $1{\cdot}65 \times 1{\cdot}0075 = 1{\cdot}66$ Å.U.; and the mass of a molecule of oxygen is $1{\cdot}65 \times 32 = 52{\cdot}8$ Å.U. From these data it would be easy to calculate the linear dimensions of the molecule if we could assume that it was spherical or cubical; but, although the early experiments of Devaux supported this view, more exact measurements have proved that the dimensions of the molecule are not equal in different directions. The molecule has, in fact, a definite shape, now open to experimental investigation, which must be taken into account in calculating its dimensions. Let me indicate three physical methods used for this purpose.

(*a*) *Viscosity of Gases.*—According to the kinetic theory of gases, the viscosity of a gas is a measure of the sectional area of the molecules. This was one of the earliest methods used to calculate molecular dimensions, and (unlike the two following methods) it is independent of a knowledge of the Avogadro constant. It has been developed in recent years by Prof. Rankine, who has deduced for the *collision-areas* of various gases values such as the following:

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[1] Compiled from lectures delivered at the Birkbeck College, London, on Jan. 25, and at Bristol on Feb. 12, 1926.

[2] *Proc. Phys. Soc.*, 1921, 34, p. 35.

TABLE I.—COLLISION-AREAS OF GASES IN ÅNGSTROM UNITS.[3]

CH_4 = 7·72 NH_3 = 6·40 OH_2 = ? HF = ? Ne = 4·17
SiH_4 = ? PH_3 = 9·11 SH_2 = 7·73 HCl = 6·76 A = 6·48
AsH_3 = 9·85 SeH_2 = ? HBr = 7·63 Kr = 7·57
SbH_3 = ? TeH_2 = ? HI = 9·26 X = 9·15

These numbers, however, do not lead directly to a knowledge of the linear dimensions of the molecules, since they merely give the average area of the molecule as viewed from every possible aspect.

(*b*) *Monomolecular Films.*—Much more detailed information is given by a study of thin films of oil on the surface of water. So long ago as 1899,[4] Lord Rayleigh explained the fact that a definite concentration of oil was required in order to diminish the surface tension of water by supposing that it was necessary to cover the water with a film of oil one molecule thick, before any effect could be produced. Since the quantity required corresponded with a film of a thickness of about 10 Å.U., he concluded that this was the approximate diameter of the molecules.

When the Avogadro number was known it was possible to compare the *thickness* of the monomolecular film with the *area* occupied by the individual molecules, and thus to get some idea of their shape. Devaux, who first made this comparison in 1904,[5] was unfortunate in that the triolein with which he worked gave a monomolecular film with a thickness of 11 Å.U., as compared with a calculated molecular diameter of 11·3 Å.U. He therefore concluded that the molecules were roughly spherical in shape, as Rayleigh had postulated; and it was left to Langmuir in 1917[6] to discover that the dimensions of the molecule are in fact widely different in different directions. Thus in Table II. the molecular area was deduced directly by dividing the total area of the film in Å.U. by the number of molecules which it contained; the width is merely the square-root of this area; but the length was calculated on the assumption that the density of the film is equal to that of the oil in bulk, and that the length of the molecule is equal to the thickness of the film.

TABLE II.—CROSS-SECTIONS AND LENGTHS OF MOLECULES.

Substance.	Formula.	Area per Molecule	Width	Length	Length per Carbon Atom.
Palmitic acid	$C_{15}H_{31}COOH$	21 Å U	4·6 Å U	24·0 Å U	1·5 Å U
Stearic acid	$C_{17}H_{35}COOH$	22	4·7	25·0	1·39
Cerotic acid	$C_{25}H_{51}COOH$	25	5·0	31·0	1·20
Tristearin	$(C_{18}H_{35}O_2)_3C_3H_5$	66	8·1	25·0	1·32
Myricyl alcohol	$C_{30}H_{61}OH$	27	5·2	41·0	1·37

To Langmuir, then, belongs the credit of discovering that, whilst the sectional area of the molecule of a saturated fatty acid or alcohol is approximately constant, corresponding with a square with a side of about 5 Å.U.,[7] the length of the chain may extend to more than 40 Å.U. As a result of these observations, Langmuir was also able to assert that the individual molecules in the film were oriented, with the acid radical immersed in the water and the hydrocarbon chain projecting outwards towards the air. The spreading of the oil into a monomolecular film could therefore be attributed to the striving of the 'hydrophilous' or thirsty 'heads' of the molecules to secure access to the water, and of the 'hydrophobic' or oily tails to escape drowning.

Most of the applications of Langmuir's conception are physical in character, as in the case of the lowering of the surface-tension of water by a film of oil. Harker, however, has recently put forward a case[8] in which the chemical properties of a compound appear to be determined by the orientation of the molecules in the surface of the liquid. Thus, he found that benzyl chloride could not be hydrolysed by dry steam, but was rapidly hydrolysed whenever there was an opportunity for liquid water to condense. This result can be explained most easily by supposing that the steam could not secure access to the active 'heads' of the molecules, since these would normally be directed towards the interior of the liquid, but that liquid water can reverse this orientation, and thus bring the chlorine into a position in which it can be attacked.

(*c*) *X-ray Analysis.*—The third method depends on investigating the distance between the mass-centres of atoms or molecules by means of X-rays. This is a reciprocal process, since our knowledge of the wave-lengths of X-rays does not yet rest on direct measurements of length, but has been deduced indirectly from the distance between the atoms of sodium and chlorine in a crystal of rock-salt, as calculated with the help of Avogadro's constant. Thus, since one gram-molecule of salt occupies 27 c.c., it is clear that the total number of atoms of sodium and chlorine in 1 c.c. of salt is $2/27 \times 0{\cdot}6062 \times 10^{24} = 0{\cdot}0452 \times 10^{24}$; but, before we can calculate the distance between the centres of these atoms, we must know how they are arranged in the crystal. A preliminary survey by means of X-rays shows that the atoms of sodium and chlorine occupy alternate points in a simple cubic lattice; we can, therefore, allot to each atom a cubic cell with a volume of $22·1 \times 10^{-24}$ c.c. (the reciprocal of the preceding number); and by taking the cube root of this number we can deduce the distance between the atoms as 2·81 Å.U. After having determined this fundamental distance, we can use a crystal of rock-salt[9] as a diffraction grating in order to determine the wave-lengths of the X-rays emitted by the elements, and we can then use these wave-lengths in order to determine the distance between the atoms or molecules in other crystals. In this way it has been shown, for example, that the distance between the carbon-atoms in a diamond is 1·52 Å U, and that the same 'atomic diameter' appears incessantly in other carbon-compounds. This diameter, indeed, is one of the most constant of the numerical properties of the element, and is the obvious basis for a modern space-chemistry of carbon compounds.

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[3] *Trans. Faraday Soc.*, 1922, 17, 720.

[4] *Phil. Mag.*, 1899, 48, 331.

[5] *Proc. Soc. Phys. Bordeaux*, April 1904; compare Smithsonian Inst. Report, 1913, 261.

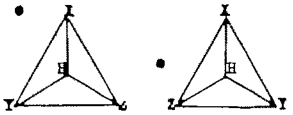
[6] *J. Amer. Chem. Soc.*, 1917, 39, 1848.

[7] The more exact measurements of Adam (*Proc. R.S.*, 1922, A, 101, 452, 516 *et seq.*) have shown that the sectional area of the hydrocarbon chain is 21·0 Å.U., but that the 'head' of the molecule occupies an area of 21·7 Å.U. in the alcohols and of 25·1 Å.U. in the fatty acids.

[8] *J.C.S.*, 1924, 125, 500.

STEREOCHEMISTRY.

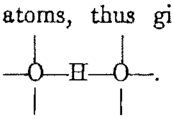
In addition to providing information as to the distance between atoms and molecules, X-ray analysis has made important contributions to our knowledge of molecular configuration or 'chemistry in space.' The first of the new chemical space-models was developed in 1874 by le Bel and Van 't Hoff, in order to account for the limited number of isomers which can be prepared of carbon compounds of various types. Thus since isomerism in derivatives of methane first appears in compounds of the type CHXYZ, these authors were led independently to postulate a *tetrahedral* configuration of the four univalent radicals around a central atom of carbon, in place of the *square* configuration of the common two-dimensional formulæ. The two opposite ways in which the four different radicals in these 'asymmetric' compounds can be arranged in space about the central atom of carbon could then be represented by alternative symbols, corresponding with the two known isomers, as follows:



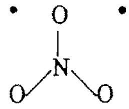
The new three-dimensional formulæ were confirmed by the experiments which led to the enunciation of von Baeyer's *Strain theory*, since it was found that a 5-atom ring with angles of 108° is more easily formed than a 4-atom ring with angles of 90°, as would be expected if the normal angle between the bonds is the characteristic tetrahedral angle, 109½°, of the solid model, instead of the right-angle of the planar formulæ.

This chemical evidence has now been confirmed by direct physical measurements. In particular, X-ray analysis has proved that the diamond is built from tetrahedrally-oriented atoms, and in such a simple manner that a child of five, if provided with a supply of rods and balls with properly adjusted sockets, could not build the model differently. A similar tetrahedral configuration of four beryllium atoms around a central atom of oxygen, and conversely of four oxygen atoms around a central atom of beryllium, has been found in basic beryllium acetate,[10] $OBe_4(O_2CMe)_6$; and the X-ray analysis of ice[11] shows four hydrogen atoms arranged in the same tetrahedral pattern about each atom of oxygen. A tetrahedral arrangement of four oxygen atoms around a central atom of sulphur has also been found in barium sulphate[12]

Moreover, in addition to confirming and extending the scope of Van 't Hoff's tetrahedral configuration, X-ray analysis has also indicated the existence of other configurations. Thus in ice, every atom of hydrogen is placed at the centre of a line joining two oxygen atoms, thus giving rise to a *linear* configuration,



$—O—H—O—$. Again, in sodium nitrate, and in calcite and aragonite, we find a *triangular* configuration of three oxygen atoms about a central coplanar atom of nitrogen or of carbon, the three oxygen atoms being ranged symmetrically about a trigonal axis, as in the schemes



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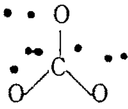
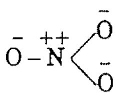


In order to preserve this trigonal symmetry, the ions in the crystal have been formulated[13] as



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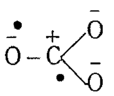

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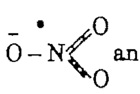

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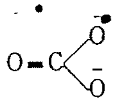

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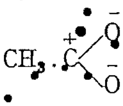
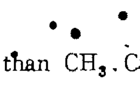
This planar configuration has been observed also in the acetate groups of basic beryllium acetate, where the two oxygen atoms are arranged symmetrically about a digonal axis, *e g.*, as in



rather than



Moreover, graphite, which was thought at one time to contain the same zigzag network of atoms that can be recognised in successive layers of a diamond, is now reported to contain a *flat* network of hexagons.[14] Since graphite has the structure of an aromatic hydrocarbon, and actually gives rise to mellitic acid $C_6(CO_2H)_6$ on oxidation, it is difficult to resist the conclusion that the characteristic form of the benzene ring may, after all be the traditional 2-dimensional hexagon rather than a zigzag hexagon in three dimensions.

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[9] Our exact knowledge of the wave-length of X-rays was formerly limited in the upward direction to about 15 Å U, because no suitable crystals of larger molecular dimensions were available to provide a grating for their investigation. Thoraeus and Siegbahn (*Ark f Mat Astron och Fysik*, Stockholm, 1925, 18, 12), however, have recently measured wave-lengths up to 21 Å U by using as a grating a crystal of palmitic acid for which $2d = 71·19$ Å U

[10] Bragg and Morgan, *Proc R S*, 1923, A, 104, 437

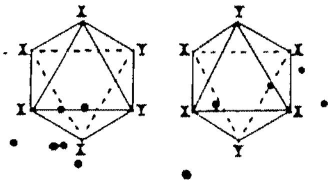
[11] Bragg, *Proc Phys Soc*, 1922, 34, 98.

[12] James and Wood, Manchester Memoirs, 1924–5, 69, No 5.

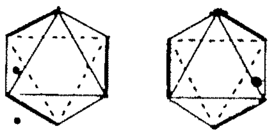
[13] *Trans Faraday Soc*, 1923, 18, 285 In these symmetrical formulæ the central atom carries only a sextet of electrons; this condition is, therefore, probably unstable except in the crystals, where the anion is surrounded symmetrically by six oppositely charged cations

CONFIGURATION OF CO-ORDINATION COMPOUNDS.

As in the case of carbon, the X-ray analysis of co-ordination compounds has proved the correctness of a configuration which had been deduced previously by purely chemical methods. Many years ago Werner concluded that the six chlorine atoms of potassium platinichloride, $K_2[PtCl_6]$, are all grouped round a central atom of platinum, instead of forming two groups, as in the formula, $2KCl, PtCl_4$. By studying the number of isomers that could be prepared of co-ordination compounds of different types, he was able to assign an *octahedral* configuration to the six co-ordinated radicals. Thus the existence of two isomers of the type MX_4Y_2 follows at once from the fact that substituents may occupy adjacent or opposite apices of the octahedron.



Werner's theory was finally established by the discovery, in compounds such as the cobalti-oxalates, $K_3[Co(C_2O_4)_3]$, of a new type of optical activity, which no one else had even suspected to be possible. This optical activity can, however, be explained immediately by means of an octahedral model, as in the following projection,[15] where the thick lines indicate the positions of the three oxalate groups.



X-ray analysis has now revealed, by direct mensuration, an octahedral configuration of the six halogen atoms in $K_2[SnCl_6]$, $(NH_4)_2[SnCl_6]$, $(NH_4)_2[PtCl_6]$, $K_2[PtCl_6]$ and $(NH_4)_2[SiF_6]$, as well as of the six atoms of chlorine which surround each atom of sodium in a crystal of rock salt. Even more important is the proof that the six molecules of ammonia in the ammoniate $NiCl_2$, $6NH_3$, are arranged in an octahedral pattern about the central atom of nickel,[16] since this confirms in the minutest detail the formulation of the compound as an *ammine* of the type $[Ni . 6NH_3]Cl_2$. Modern physics has thus provided a new and very secure foundation for an important item of belief, which has only recently been added to the chemists' creed.

IONISATION.

During a period of forty years, physical chemists have asserted that when an electrolyte is dissolved in water it is partially dissociated into free ions

$$NaCl \rightleftharpoons \overset{+}{Na} + \overset{-}{Cl}.$$

No adequate basis was provided for this "nonsensical hypothesis" (as Prof. Armstrong described it in a letter to NATURE of November 26, 1896), "which asserts that hydrogen chloride and a few other compounds are so loosely strung together that they fall to pieces when dissolved in water . out of sheer fright it would seem, as no valid motive is suggested for such self-sacrifice." An excuse for this strange conduct was afterwards found in the affinity of the ions for water, but at the time the 'dissociationists' preferred to use the 'blessed word' *allotropy*[17] as a mask to conceal the difficulty of explaining the supposed indifference towards one another of oppositely charged atoms of sodium and chlorine, as contrasted with the violent interaction of metallic sodium with gaseous chlorine and the still more violent interaction that might be expected between the atoms of the two elements. The more concrete suggestion that "the atoms of the dissolving electrolyte evolve heat by combining with their electric charges,"[18] was laughed out of court as being absurdly opposed to sound physical doctrine, since experience had shown that energy was always used up in the electrification of matter, and that the energy required to impart a given charge to a spherical conductor was inversely proportional to its diameter, and must therefore be enormous in the case of single atoms

Modern physics has turned this problem inside out, since it is the molecules, and not the ions, of a salt of which the existence is now questioned. Thus, according to current views, the metals are so ready to lose electrons and the non-metals to gain them, that the ions of a salt are more stable than the corresponding neutral atoms. It is therefore impossible for these ions to neutralise their opposite electrical charges in order to produce a neutral molecule of salt. The utmost that can be done is for two oppositely charged ions to cling together to form a loose doublet, which is always free to interchange ions with another similar doublet. This state of affairs prevails no doubt in the vapour, as well as in concentrated aqueous solutions. Dilution with water then produces a real 'electrolytic dissociation,' $\overset{+}{\mathrm{Na}}\overset{-}{\mathrm{Cl}} \rightleftharpoons \overset{+}{\mathrm{Na}} + \overset{-}{\mathrm{Cl}}$, in which ready-formed ions are merely separated from one another, *e.g.* by the intrusion of molecules of the solvent, instead of being created *de novo* from neutral molecules.

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[14] Bernal, *Proc R.S.*, 1924, A, 106, 749, Hull, *Phys Rev*, 1917, 10, 661, Debye and Scherrer, *Phys. Zeitschr*, 1917, 18, 291.

[15] *Chemistry and Industry*, March 9, 1923, 42, 224 This projection, which I suggested in 1923 as a substitute for that used by Werner, has the same hexagonal outline as the diagram commonly used to represent the derivatives of benzene It has the advantage of showing clearly that the metallic atom in the cobalti-oxalates is dissymmetric, but not asymmetric, since the model has one axis of 3-fold symmetry and three axes of 2-fold symmetry.

[16] Wyckoff, *J A C S*, 1922, 44, 1239

[17] Ostwald, "B A. Report," 1890, 333.

[18] NATURE, Dec. 17, 1896, p 151.

This revolutionary doctrine is supported by the X-ray analysis of salt, which reveals the fact that every atom of sodium is surrounded symmetrically by six atoms of chlorine and conversely. Since there is no difference in the distances which separate a given atom of sodium from six neighbouring atoms of chlorine, there is no experimental justification for asserting that any one of these atoms is combined selectively with the central atom of sodium to form a molecule. On the other hand, crystallographers state that the crystal of salt is not holohedral like Bragg's model, but hemihedral, so that there may be some factor in the structure of the crystal which is not revealed by examination with X-rays.

Physical chemists have not been slow in following up the lead thus given, and have been able to prove that many of the properties of dilute salt solutions can be explained by the *electrostriction* between oppositely charged ions, distributed just as in a crystal of rock-salt, but in a more irregular manner and at a greater average distance from one another.

CHEMICAL AFFINITY.

The combination of unlike elements, *e.g.* of metals with non-metals, which is so important in inorganic chemistry, was explained some twenty years ago by J. J. Thomson[19] as due to a process of *electron-transfer*, *e.g.* to the transfer of an electron from an atom of sodium to an atom of chlorine. The chemical affinity between sodium and chlorine was then attributed to the electrostatic attraction between oppositely charged atoms of the two elements.

In its most elementary form the new electrochemical theory was not very much in advance of that put forward a century before by Berzelius, since it gave no precise explanation to show why an atom of sodium should be ready to part with an electron or an atom of chlorine to accept one. Even in the hands of Ramsay,[20] therefore, it did not render any important help to chemists in solving the difficult problem of the nature of chemical affinity. When, however, we had not only learnt from J. J. Thomson of the existence of the electron, and of its presence as a common constituent of all atoms, but had also been taught by Moseley how to count the electrons in the atom of each element, the situation was altered profoundly. Thus it was at once apparent that potassium with 19 electrons has only to lose a single electron, as J. J. Thomson had supposed, in order to acquire the stable grouping of 18 electrons which is characteristic of argon; and conversely, that chlorine with 17 electrons can acquire this stable configuration by gaining one electron. A motive for the transfer of an electron, and an explanation of the origin of this polar type of chemical affinity, can therefore be found in the exceptional stability of a group of 18 electrons, as contrasted with the relative instability of a grouping of 17 or 19 electrons, around a positively-charged nucleus.[21] Indeed, only one important section of the problem now remains unsolved, namely, that we cannot explain why the properties of an inert gas should appear in successive members of the series

$$2+8+8+18+18+32 \text{ electrons},$$

or what feature of the quantum theory dictates the formation of the sub-groups of 2, 3, 4, or 6 electrons, which by their summation give rise to the large groups of Rydberg's series:

$$2\times1^2+2\times2^2+2\times2^2+2\times3^2+2\times3^2+2\times4^2 \text{ electrons}$$

Apart from this, the whole phenomenon of *electrovalence*, as Langmuir calls it, with its attendant theory of the complete and permanent ionisation of mineral salts such as $\overset{+}{\mathrm{Na}}\overset{-}{\mathrm{F}}$ or $\overset{+}{\mathrm{K}}\overset{-}{\mathrm{Cl}}$, seems to be transparently clear.

Nevertheless, just as Berzelius' dualistic theory collapsed when faced with the facts of organic chemistry, so the theory of electron-transfer breaks down in face of the problem of explaining the mutual affinity of *like* elements. This is a serious fault, since the union of like atoms not only dominates the whole of carbon chemistry, but is also responsible for the formation of simple inorganic molecules such as H_2, O_2, N_2, or Cl_2. This second or 'non-polar' type of chemical affinity, however, has also received a clear explanation as a result of the study of atomic numbers. Thus it appears that two atoms, each of which is one electron short of the number required to produce the stable configuration of an inert gas, can acquire this configuration by a simple process of *electron sharing*.[22] In this process a *duplet*, or pair of electrons, is held in common as an integral part of the electronic configurations of the two atoms which it unites, just as the two aromatic rings in naphthalene are united by the two carbon atoms which are common to both rings.

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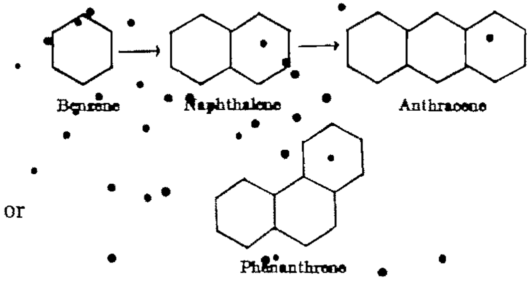
[19] *Phil. Mag.*, 1904, 7, p. 262.
[20] *J.C.S.*, 1908, 93, 774.
[21] See especially Kossel, *Ann. d. Phys.*, 1916, 49, 229.
[22] G. N. Lewis, *J.A.C.S.*, 1916, 38, 762; "Valence," 1923, p. 74.

In this scheme of electron sharing there does not appear to be any *a priori* reason why two atoms should not be united by sharing *one* electron; and indeed Main-Smith[23] has postulated that this is a normal method of union in co-ordination compounds; but the evidence offered in support of this view is very slender and in general it appears to be a *pair* of electrons that performs this function, just as *pairs* of carbon atoms are shared when one six-atom ring is added to another on passing from benzene, C_6H_6, to naphthalene, $C_{10}H_8$, and then to anthracene or phenanthrene, $C_{14}H_{10}$.



Two electrons held in common are therefore the equivalent of a *single bond*, or *covalence* as Langmuir calls it, whilst four or six electrons held in common give rise to a *double bond* and to a *triple bond* respectively.

The groups of eight electrons in the Rydberg series are generally depicted as occupying the eight corners of a cubical octet. A single bond is then represented by a pair of cubes with a common edge, and a double bond by a pair of cubes with a common face; but on this basis the formation of a triple bond would result in a complete superposition of the two cubes, and would thus give rise to a quadruple bond, with four pairs of electrons held in common instead of only three. The new model, therefore, fails to represent the property of forming single, double, *and triple* bonds (and the impossibility of forming a quadruple bond) which are expressed so well by the sharing of a corner, an edge and a face of the tetrahedra of le Bel and Van't Hoff. Indeed, further progress is possible only when we abandon the cubical model in favour of a purely algebraic form of the theory, or else adopt a different geometrical model, *e.g.* by supposing that the octet contains four tetrahedrally arranged duplets instead of eight equally distributed single electrons. This tetrahedral model enables us to see why, in the elements of the first short period, there is no large change of boiling-point on passing from $F-F$ to $O=O$ and $N\equiv N$; but when we come to carbon, where a quadruple bond between two atoms is impossible, the boiling-point suddenly rises by 3500°. This dramatic rise of boiling-point is obviously due to the fact that the spare bonds, which are left over after uniting the atoms in pairs by single, double, or triple bonds, interlock, until both in diamond and in graphite the molecule extends to the boundary of the crystal, and vaporisation is only possible by disrupting atoms from this enormous molecular complex. If the cubic model were valid, this abrupt change should occur on passing from the double bond of oxygen to a prohibited triple bond in nitrogen, instead of on passing from the triple bond of nitrogen to a prohibited quadruple bond in carbon.

ORIGIN OF CHEMICAL AFFINITY.

By postulating alternative types of union, the electronic theory of valency enables us to recognise at a glance the existence of two types of chemical affinity, namely, a non-polar affinity between like atoms and a polar affinity between unlike atoms. It has the further advantage of referring both types of affinity to a common cause. This cause, long suspected to be electrical in origin, has at last been disclosed as depending on a mysterious force which compels the electrons, when under the influence of a positively-charged nucleus, to form stable aggregates of 2, 8, 18, or 32 electrons. The origin of these numbers, and of the sub-groups into which they can be further resolved, is, however, a secret which the quantum theory has not yet completely disclosed.[24]

TWO THEORIES OF VALENCY.

During the last fifty years, organic chemists have accepted Van't Hoff's tetrahedron as a correct working model of the carbon atom. This conception of valency was vigorously attacked, however, in 1905, by Werner, who, in his "Neuere Anschauungen" (p. 73 of the English translation), asserted that "Affinity is an attractive force which acts from the centre of the atom and is of equal value at all points on its surface. With such a definition of affinity it naturally follows that separate units of affinity do not exist." In this paragraph, Werner challenges both the limited number and the fixed orientation of the four positions which are available for the attachment of other atoms in Van't Hoff's tetrahedral model. Bearing in mind the distortion of the tetrahedral angles, which is permitted by von Baeyer's 'strain theory,' Van't Hoff's model of the carbon atom can be represented most conveniently by a sphere with four sockets, each socket carrying an elastic rod to represent a bond by which the carbon atom is united to another atom. Werner's alternative conception can be represented most conveniently by Emil Fischer's model, in which the 'atom' takes the form of a sphere covered all over with bristles, a sort of spherical scrubbing-brush, which resembles the involucre of a burdock in that two 'atoms' will stick together at any point of contact, and in any number up to the limits of space available.

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[23] *Chem. and Ind.*, March 28, 1924, 43, 323.

[24] An interpretation of the periodic system, based upon the view that each planetary electron in the atom occupies a unique type of orbit characterised by *four* quantum numbers, has recently been described by Landé (*Die Naturwissenschaften*, July 1925, 13, 604), see also Sommerfeld (*Phys. Zeits.*, Jan 1, 1925, 26, 70-74), and Pauli (*Zeits. f Physik*, 1925, 31, 765-782).

Although Werner considered it necessary to denounce Van't Hoff's conception of valency as incompatible with his own more comprehensive views, it is now clear that these two theories are not in fact competing alternatives, since each is correct in its own domain, but incorrect if applied outside it. Thus Werner's theory of valency gives us an ideal representation of the behaviour of the closely packed ions in a crystal of rock-salt, and agrees precisely with the behaviour which we should expect of compounds which are held together only by *electrovalence, i.e.* by the mutual attraction of oppositely charged ions. It is, however, incapable of explaining the open lattice structure of the diamond, which can only be arrived at by limiting the number of points of attachment to four, and at the same time fixing their orientation around the atom, precisely as in Van't Hoff's model. This behaviour is characteristic of all compounds in which the atoms are held together by *covalence, i.e.* by the real *bonds* of the organic chemist. We therefore have alternative conceptions of valency, namely, Werner's theory, which expresses the type of chemical affinity that is dominant in mineral chemistry, and Van't Hoff's theory, which expresses the phenomena of organic chemistry; and we now find that these two theories correspond precisely with alternative aspects of the electronic theory of valency, which predicts the possibility, and compels us to recognise the real existence, of both types.

THE TWO TYPES OF VALENCY.

In general the two types of valency can be distinguished by merely counting the electrons. Thus, since the potassium ion and the chlorine ion have each a complete outer shell of eight *M*-electrons, we cannot replace the electrovalence by a covalence, since this would create a surplus of two electrons over and above those required to complete two stable 'argon' systems. On the other hand, a molecule of chlorine, with a total of only $2 \times 7 = 14$ *M*-electrons, must be held together by a covalence, *i.e.* by sharing two electrons, since if the atoms were torn apart we could only assign a complete octet of *M*-electrons to one atom, leaving the other with a sextet or incomplete group of six electrons. The conversion of the covalence into an electrovalence, as represented by the equation

$$\mathrm{Cl_2} \rightleftharpoons \overset{+}{\mathrm{Cl}} + \overset{-}{\mathrm{Cl}},$$

may perhaps occur when the bond is broken by the rupture of the molecule when undergoing chemical change; but this ionisation of the bond can only give rise to an unstable condition, which would always tend to revert to a more stable one in which each atom is able to complete its octet.

We can also distinguish the two types of valency by noticing that the 'polar' type of chemical affinity is indefinitely divisible, like Werner's uniform 'spheres of affinity,' but that the real bond of Van't Hoff's model cannot be divided. Thus in rock-salt the chemical affinity of each 'univalent' sodium atom appears to be divided equally amongst six 'univalent' atoms of chlorine and conversely; but in the diamond the four bonds of the 'quadrivalent' carbon atom are used as integers, each bond serving to unite two atoms, and two only. Whenever, therefore, mention is made of residual affinity, or of partial valencies, I at once suspect that these valencies must be *polar* rather than *non-polar* in character. This view was foreshadowed in 1899 by Thiele,[25] when formulating his new theory of *conjugation*, and I do not know of any evidence which would contradict it.

Even more important is the fact that, whilst an electrovalence can act in any direction round the atom, a real bond or covalence is fixed in direction. In the former case there is nothing to prevent the ions from being packed as tightly as their volumes will permit. This condition is realised in the crystal-structure of rock-salt, $\overset{+}{\mathrm{Na}}\overset{-}{\mathrm{Cl}}$, which is a close-packed aggregate of equal numbers of ions of opposite signs, and of fluorspar, $\overset{-}{\mathrm{F}}\,\overset{++}{\mathrm{Ca}}\,\overset{-}{\mathrm{F}}$, where there are twice as many ions of one sign as of the other. On the other hand, the atoms of carbon in diamond are very far from being close packed, since each atom is surrounded immediately by only *four* other atoms, whereas each of Werner's spheres would be able to make contact with *twelve* other spheres of equal size. Indeed, it can easily be calculated that, if Werner's conception were correct in this particular case, and Van't Hoff's conception were wrong, the close packing of the spheres would increase the density of the crystal in the ratio of 6·5 to 8. Similar open lattices are found in many other crystals, and it is safe to assert that they can always be associated with the presence of valencies which are limited in number and fixed in direction, precisely as postulated by le Bel and Van't Hoff. Thus, if ice and quartz were mere aggregates of oppositely charged ions,

$$\overset{+}{\mathrm{H}}\,\overset{--}{\mathrm{O}}\,\overset{+}{\mathrm{H}} \text{ and } \overset{--}{\mathrm{O}}\quad\overset{++++}{\mathrm{Si}}\quad\overset{--}{\mathrm{O}}$$

we should expect them to crystallise in the same form as fluorspar, where also there are twice as many ions of one sign as of the other. Actually, both ice and quartz crystallise in a totally different manner; and the lattice-work of ice is so open that the density of the aggregate is less than 1. We can therefore assert that the atoms of both compounds are united by real bonds and not by the mere electrostatic attraction between oppositely charged ions. A similar argument has already been applied in the case of iron pyrites, FeS_2, where the sulphur atoms are all paired, instead of being distributed uniformly like the atoms of fluorine in fluorspar. The compound is therefore not a sulphide of quadrivalent iron $\overset{--}{S}\ \overset{++++}{Fe}\ \overset{--}{S}$; but a ferrous disulphide, $\overset{++}{Fe}\ \overset{-}{S}\text{——}\overset{-}{S}$, in which each pair of sulphur atoms is held together by a bond, in addition to carrying a double negative charge. It is, indeed, clear from these examples that the X-ray analysis of crystals provides a very precise experimental method for distinguishing between the two types of valency, and is of fundamental importance for this purpose.

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[25] *Ann.*, 1899, 306, 87.

POLAR, SEMI-POLAR, AND NON-POLAR DOUBLE BONDS.

Three years ago I pointed out[26] that since single bonds can be of two types, namely:

(i) Polar, as in $\overset{+}{Na}\overset{-}{Cl}$.
(ii) Non-polar, as in Cl—Cl, H—H or $CH_3 . CH_3$;

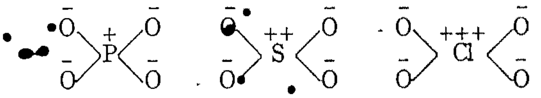
double bonds should be of three types, namely:

(i) Polar, as in $\overset{++}{Ca}\ \overset{--}{S}$,
(ii) Non-polar, as in O=O,
(iii) Mixed (or semi-polar), as in $Me_3\overset{+}{N}\text{—}\overset{-}{O}$.

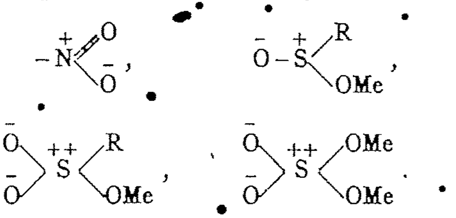
In particular, a mixed or semi-polar double bond was postulated in trimethylamine oxide

$$\overset{+}{N}Me_3-\overset{-}{O}\ (\text{compare } \overset{+}{N}H_4\overset{-}{Cl}),$$

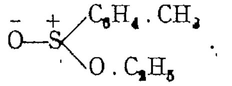
and in the ions of oxy-acids[27]



The existence of this new type of double bond has now been established by two independent experimental methods, depending respectively on the study of molecular volumes and on the detection of molecular dissymmetry. The work on molecular volumes, begun more than half a century ago by Kopp, has culminated in the recent researches of Sugden,[28] who has discovered a function of the molecular volume which is (i) independent of the temperature of observation, (ii) a strictly additive function of the constituent atomic volumes. In these investigations the molecular volumes are reduced to *equal surface tensions*, by making use of a function $\gamma^{\frac{1}{4}}\frac{M}{D-d}$ (where γ = surface tension, M = mol. wt., D = density of liquid, d = density of vapour), which Sugden describes as the *parachor*. The value of this function is increased by 23 units by each *non-polar* double bond, whatever the atoms which it joins, *e.g.* $>C=O$, $>C=C<$, $>C=N-$, $-N=O$; but the *semi-polar* double bonds in the systems $>SO$, $\geq NO$ and $\geq PO$ were found to produce a minute *decrement* of molecular volume.[29] In this way the nitro group was shown to contain only one non-polar double bond, whilst the sulphinates, sulphonates, and sulphates do not contain any



More important still is the proof given by Phillips,[30] that the sulphinates (in which the existence of semi-polar double bonds was established by Sugden's measurements of density and surface tension) can be obtained in optically-active forms, as in the case of the ethyl tolylsulphinate of the formula



If the sulphur and oxygen were united by a symmetrical non-polar double bond, the compound would, on the basis of the older space formulæ, be obviously symmetrical. Moreover, since none of the earlier theories of valency was capable of predicting the asymmetry of these compounds, the experimental realisation of this new type of optical activity provides an excellent illustration of the value of the electronic theory of valency, as well as a decisive vindication of the more specialised conception of mixed or semi-polar double bonds. We have here, indeed, a further example of the general rule, already illustrated in the case of Werner's theory of co-ordination, that each new development of the theory of valency has been accompanied by, and has received its final sanction from, the discovery of a new kind of optical activity.

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[26] J.C.S., 1923, 123, 822.
[27] Trans. Faraday Soc., 1923, 18, 285; Phil. Mag., 1923, 46, 1105.
[28] J.C.S., 1924, 125, 1177.
[29] Sugden, J.C.S., 1925, 127, 1525.
[30] J.C.S., 1925, 127.

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Supplement to NATURE

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Our Bookshelf.

Studies in Psychology.

Behaviorism. By Prof. John B. Watson. Pp. iv+248. (London: Kegan Paul and Co., Ltd., 1925.) 12*s.* 6*d.* net.

IN his new book Dr. Watson gives a vigorous exposition of his methods and results already familiar to readers of his earlier works, notably "Psychology from the Standpoint of a Behaviorist." It contains, however, some fresh material and foreshadows an ambitious attempt to apply the principles of behaviouristic psychology to all the mental and social sciences. All categories involving reference to consciousness, such as knowing, feeling, striving, are to be eliminated and their place is to be taken by a purely naturalistic study in terms of reflexes and their 'conditioning.' His attitude to the problem of the nature of instinct is more drastic than in his earlier writings. All alleged human instincts are, according to his present view, really habits built up by selection from original responses by processes of conditioning. Emotions, of which there are only three primary ones—namely, fear, [illegible]e, and love—are nothing but visceral responses. [illegible] 'unconscious' of the psycho-analysts consists, in [illegible], of bodily and visceral habits that have never [illegible]balised and cannot be recalled. Modification [illegible]viour or 'learning' is due to the conditioning [illegible]nses and the formation of habits. Thinking is [illegible]ng, and is made up of laryngeal habits.

[illegible] Dr. Watson's exposition is aggressively [illegible]d confident, but he makes no real effort [illegible]h the difficulties of his position. This [illegible]icularly to his discussion of 'memory,' [illegible]nd 'thinking,' in each of which recent work [illegible]o bring out the inadequacy of explanations [illegible]uch factors as recency and frequency of [illegible]e, to which alone he appeals. The book [illegible]number of records of observations, particu[illegible] dealing with the behaviour of infants, [illegible]mportant and useful, but on the theoretical [illegible]rks no advance, and the claim that the [illegible]embodied in it are destined to revolutionise [illegible]eligion, sociology, and other social sciences [illegible]t strike the reader as naively extravagant.

M. G.

[illegible]ology of Handwriting.* By Robert Saudek. [illegible]-288. (London: George Allen and Unwin, [illegible]25.) 12*s.* 6*d.* net.

[illegible]GY, the study of handwriting in popular con[illegible] placed on something of the same level as [illegible] except that, in the case of the former, experts [illegible]nes called upon to give evidence as to matters [illegible] the law courts. It will therefore, perhaps, [illegible] surprise to some to find a volume of no small [illegible]s devoted to the study of the subject on scientific lines, and further, to find that it contains a chapter on the history of the subject. Attempts at 'characterological' interpretation of handwriting begin with a book by Camille Boldo, published at Capri in 1622. In 1830 there was a school of interpretation to which Bondinel, Bishop of Amiens, Cardinal Régnier, and Abbé Flandrin belonged; but the history of graphology really begins with Abbé Hipolite Michon, a pupil of the last named, who was followed by Crépieux Jamin, the most eminent of the French graphologists. It was, however, in Germany that an attempt was made by Georg Meyer and Ludwig Klages, at the end of the last and the beginning of the present century, to place the study on a truly scientific inductive basis.

The author of the present work, in addition to an exhaustive study of the methods of both French and German schools, has had twenty-five years' experience in the study of handwriting, and here puts before his readers the results of his adaptation of these methods to English and American styles and methods in handwriting. So far as they go, his methods, taking into account mechanical and material conditions and the physiology of writing, must be accepted as sound in principle and method. It is when he comes to the psychology of writing that he is on less certain ground. It must be admitted, however, that his reasoned analyses of specimens of handwriting of well-known individuals do indeed appear to tally with the facts so far as generally known.

Animal Life.

Our England: Twelve Open-Air Lessons. By Patricia Johnson. Pp. viii+104. (London: Methuen and Co., Ltd., 1925.) 2*s.*

THIS little text-book, which is neither purely geographical nor historical, but contains a little about everything, deserves more than passing mention. In the first place, it represents in substance some of the first broadcast lessons ever given by radio: they were broadcast from the London station in the spring of 1925; and secondly, because they are excellent of their kind. Few books of this size contain so much excellent matter packed within so small a space. The weather, domestic animals, the farmer's year, wild animals, archæology, history, geography, folklore, economics, and the history of traditional civic institutions in England, all find a place, treated in such a way as to stimulate rather than to satisfy inquiry.

The Aquarium Book. By E. G. Boulenger. Pp. 208+16 plates. (London: Gerald Duckworth and Co., Ltd., 1925.) 10*s.* 6*d.* net.

THE greater part of this book is devoted to popular accounts of a large number of species of aquatic animals. The value and history of aquarium-keeping are also briefly surveyed and hints given on the management of aquaria.

The book is very attractively written and should have a wide appeal. Its perusal will greatly enhance the interest of visits to the Zoological Society's aquarium and stimulate the enthusiasm of amateur aquarists. It is a great pity, therefore, that care has not been taken to avoid the far too numerous errors, exaggerations, and loose statements in the information provided. Examples of such are a statement on p. 34 that all protozoa have a flagellum, and one on p. 107 that steam-trawling destroys the eggs of the plaice. Misprints and mistakes in punctuation are numerous. On p. 166 the author confers knighthood on Isaak Walton. The few photographs are excellent: the drawings, in some cases good, in others leave much to be desired. On p. 50 the cotton-spinner, *Holothuria nigra*, is misrepresented by a drawing of quite a different species. It is hoped a second edition will appear, carefully edited to remove such blemishes from an otherwise attractive and useful book.

Reproduction in the Rabbit. By John Hammond. With Foreword and Chapter on the Formation of the Corpus Luteum by F. H. A. Marshall. (Biological Monographs and Manuals, No. 4.) Pp. xxv+210+20 plates. (Edinburgh and London: Oliver and Boyd, 1925.) 15*s.* net.

THIS is an admirable book, containing not only an excellent and up-to-date account of the reproductive phenomena of the rabbits, but also a mass of original results derived from the personal investigations of the author. The book is prefaced by an excellent short outline of the processes involved in the sexual cycle, by Dr. F. H. A. Marshall, who also appropriately contributes the chapter upon the formation of the corpus luteum.

Mr. Hammond's work is clearly written and is well illustrated by charts and half-tone blocks. It will be found indispensable by all specialist students of mammalian reproduction, but will also prove most useful and most interesting to the ordinary biologist interested in a more general way in the phenomena of reproduction.

The Breeding of Foxhounds. By Earl Bathurst. Pp. xiii+132+8 plates. (London: Constable and Co., Ltd., 1926.) 21*s.* net.

THE scientific principles of animal breeding are still obscure: yet the success of the practical man, from the days of Jacob's matrimonial venture onwards, are for all to see. Probably the modern dog, particularly the sporting dog, provides the best example of man's skill in moulding wild animals to his purposes; for, if Darwin was right, the raw material was the wolf, the dingo, and the like—most unpromising material out of which to build up a being of almost human intelligence. This book, based, as it is, on the accumulated experience of nearly forty years of breeding hounds (the author being the well-known and successful Master of the V.W.H.-Cirencester Hounds), is deserving of the careful study of all—and they are many—who are interested in the practical problems of hound-breeding. Earl Bathurst is clearly a master of his subject, and does not object to disclosing, as so many practical breeders of animals do, the secrets of his methods. It is open to doubt, however, whether science, Mendelian or other, can do much to aid. The author devotes, it is true, a chapter to Mendelism, but the methods he applies owe their main justification to the practical success which has followed them. The qualities of the perfect hound, we are told, are "voice, nose, drive, stoutness, and looks." The geneticist would scarcely venture to describe these as Mendelian 'unit characters,' or even assert their dependence on 'genes.'

It is interesting to observe how the dread of inbreeding dominates the practical breeder. "Study the pedigrees," says the author, "so as to avoid breeding too closely." Yet we know that, as a matter of practice, close inbreeding was applied by all the great 'improvers' of cattle and sheep, and modern science asserts that inbreeding, in itself, is not harmful. Certain it is that fixity of type can be obtained by this practice and no other. The 'line' breeding which the author practises is, after all, simply a diluted system of this nature. The book is handsomely produced. The photograph of the author's Trouncer, 1923, will excite the envy of every hound lover.

Hygiene and Health.

(1) *The House of Health: What the Modern Dwelling Needs to Be.* By Sir John Robertson. Pp. 192. 2*s.* 6*d.* net.

(2) *Nursing in the Home: including First Aid in Common Emergencies.* By Stella Churchill. Pp. 197. 2*s.* 6*d.* net.

(3) *The Fight against Infection.* By Lieut.-Col. G. E
Stammers. Pp. 214. 2*s.* 6*d.* net.

The Modern Health Books. (London
and Gwyer, Ltd., 1925.)

THESE three examples of the series of "Modern
Books" which are being issued serve to illust
scope and method of treatment of the su
The matter is limited to essentials and i
simple non-technical language, the type
are pleasing, and the volumes are light an

(1) Sir John Robertson gives all the ess
which are required to make a healthy dw
addition to the actual construction of the
discusses the environment, drainage, wate
smoke abatement. As regards constructi
terre and steel houses are alluded to, and ti
are recommended as both comfortable a
The old-fashioned sash window is recom
being the best for cottage lighting and
with which we agree. Tongued and gro
boards are advocated, but certainly add to cos
small but important practical details are re
e.g. the size of bath for artisan dwellings, th
ness of some baths, enamelled taps to sa
We are glad to note that the author has a
to say for the earth-closet in rural distric
would emphasise its value in these circum
providing a source of manure for the garde
stable manure is becoming scarce and costly

(2) A good survey of the art of home nur
presented. Practical nursing details are inc
directions are given for the nursing of c
infectious and some other diseases, and

cases. Directions are given for the treatment of emergencies (such as fits, drowning, and poisoning), and of some common minor ailments. No caution is given of the irritant effect of formalin in connexion with disinfection, and we have failed to find a mention of that common and alarming ailment of children—spasmodic croup.

(3) Col. Stammers has been able briefly to describe the causation and means of prevention of many of the ills to which flesh is heir. Two brief chapters serve to introduce to the reader the nature of parasites, vegetable and animal, and to give an account of some of the means by which the body resists infection. A fascinating narrative then follows of several important diseases, including plague, cholera, typhoid fever and sleeping sickness, and guinea-worm and tapeworm infections. A short chapter on scientific research is included, which should impart to the non-scientific reader some idea of what research work is.

The text is illustrated with figures of parasites and their intermediate hosts and charts of geographical distribution. We notice a slip in the legend of Fig. 13, where the diagram of the female guinea-worm is stated to be "highly magnified," though in the text the worm is rightly described as being about a yard in length. It would be better also, we think, not to refer to *Taenia solium* and *T. mediocanellata* as the "pig" and "beef" tape-worms respectively, as in the tape-worm stage they are essentially human.

Indian Forestry and Timbers.

India of To-Day. Vol. VI.: *India's Forest Wealth.* By E. A. Smythies. Second edition. Pp. xv + 137 + 12 plates. (London: Oxford University Press, 1925.) 3*s.* 6*d.* net.

FORESTRY is a subject on which the average politician is profoundly ignorant. A very high proportion of the Indian public have hitherto had very little direct interest in the forests. As a people they are extraordinarily economical both in the use of fuel and timber. Only a comparatively small proportion of the population live in the vicinity of the remaining forests. In spite of the fact that enormous quantities of produce are given away annually to rightholders (estimated very conservatively at 1,000,000*l.* worth), the general attitude of those directly interested in the forests is one of grievance against the restrictions of the Forest Department as to free fuel, timber and grazing. This grievance, coupled with the fact that the present annual surplus from Indian forests after approximately seventy years of conservation and development has only increased from 80,000*l.* to 1,300,000*l.*, is reflected in the attitude of the majority of Indian politicians, who in general are hostile to forest development. The present work, prepared by Mr. Smythies in collaboration with provincial officers, is therefore very timely. It emphasises the enormous indirect benefits derived from India's forest estates and their value to the population as a whole; it describes what the Forest Department has already accomplished; and it explains very clearly the urgent need of further investment of capital in the forests if the exchequer in the course, say, of the next fifty years is really to benefit directly from the investments already made.

An Elementary Manual on Indian Wood Technology. By Dr. H. P. Brown. Pp. xiii + 121 + 16 plates. (Calcutta: Government of India Central Publication Branch, 1925.) 4 rupees; 6*s.* 9*d.*

THERE has been a certain amount of prejudice in the past against the use of the microscope for the identification of timber, the reason generally given being that it is impracticable for use in the field. The number of different timbers, however, which now need to be distinguished has increased so enormously that opinion has veered to the other extreme, and many regard any attempt to identify a timber without the aid of the microscope as so much guess-work. J. S. Gamble's "Manual of Indian Timbers" has for many years been the only important work in this particular field, but unfortunately contains no microscopic data. There has consequently been a growing need of a text-book for the training of Indian forest officers in the anatomy of the timbers of India. As Dr. Brown points out in his preface, to teach students in terms of timbers which they will never handle is neither efficient nor conducive of the maximum possible interest. It is to remedy this defect that this volume has been written, and that it will go a long way towards doing so is not to be doubted. It should also prove of value to those interested in the timbers of tropical countries other than India.

The microscopic features of wood are described more fully than the gross features and physical properties, but the latter are quite clearly and concisely set out. Admirable use has been made of a large number of original photomicrographs and drawings, both of which are excellent, and a key is appended for the identification of sixty of the more important Indian woods.

L. C.

Earth Structure and History.

Geological Maps: the Determination of Structural Detail. By Robert M. Chalmers. Pp. vii + 175. (London: Oxford University Press, 1926.) 12*s.* 6*d.* net.

THE study of geological maps and structures is perhaps one of the most difficult parts of any advanced geological course, and until recent years there has been no guidance in the way of text-books available to students. There are now several books from which a selection may be made, and this, the most recent addition to the growing literature of the subject, seems likely to make the widest appeal. It is intended not only for geologists, but also for students of mining, and many of the examples in the text have been chosen to illustrate problems arising in the working of coal seams. The purely geological student, however, will find such difficult structures as recumbent folds quite adequately treated, and it is noteworthy that examples are taken from the Ballachulish and Appin folds.

The author has a wide knowledge of geological evidence and its interpretation, and besides dealing with the familiar topics, outcrops, thickness and dip of beds, faults, etc., chapters are also devoted to igneous rocks and geosynclines, while an appendix gives a brief account of the theory of isostasy. The book can be warmly recommended to teachers and students as a thoroughly successful text-book, while the publishers are themselves a sufficient guarantee that the book is well and attractively printed.

An Introduction to Earth History. By Prof. H. Shimer. Pp. viii+411. (Boston, New York and London: Ginn and Co., 1925.) 12*s.* 6*d.* net.

Prof. Shimer is to be congratulated on having achieved a very definite success in his attempt to compress into a small book a thoroughly adequate, well-proportioned, and completely up-to-date survey of geology and its border subjects. The treatment is far from following the conventional lines usually adopted. Part 1 deals with the 'evolution' of matter and stars, and so leads up to the birth of the solar system and the origin of the earth. The recent tidal theory of Jeans and Jeffreys is briefly summarised, and radioactivity is discussed with the view of applying it later to the measurement of geological time and the problems associated with the earth's internal sources of energy. Part 2 briefly describes the processes at work on the surface of the earth and within it; and at greater length the sequence of events, due to the interaction of these processes, which constitute geological history. Part 3 is devoted entirely to the history of life, and gives in broad outlines a most useful summary of the evidence for and the results of organic evolution.

From the most modern applications of radioactivity to dinosaurs' eggs the book reaches the newest fringes of a rapidly advancing subject, and presents it everywhere as a science in active growth towards maturity. The book is well written, cultured and philosophical in tone, and will serve alike for the general reader and the non-specialising student to give a general picture, described by an authoritative guide from a modern point of view, of the progress that has so far been made in our interpretation of the earth's history and that of its inhabitants.

A Text-Book of Geology: for use in Universities, Colleges and Engineering Schools. By Prof. James Park. (Griffin's Scientific Text-Books.) Second edition, revised and enlarged. Pp. xix+527+72 plates. (London: Charles Griffin and Co., Ltd., 1925.) 30*s.* net.

This comprehensive elementary text-book has enjoyed a quiet popularity for twelve years, particularly amongst mining men, to whom the author, Prof. James Park, is well known for his works on mining and metallurgy. This, the second edition, has been considerably revised, though not so fully as one would have wished, for in many respects it is not adequately up-to-date, and reference to the bibliography definitely shows that many important works of the last decade have not been utilised. Although the first edition contained 598 pages, the present volume is considerably larger because of the adoption of a bigger page-size. It includes new matter dealing with the history of geology, the origin of coral reefs and atolls, mountain building, and the formation of ore deposits. In the revision of the section discussing the age of the earth, the longer estimates of geological time are wrongly ascribed to Joly. The book begins with physical geology and includes a brief summary of mineralogy and petrology. The second part, dealing with historical geology, is noteworthy for the many excellent plates illustrating fossil forms. Special prominence is given to the comparative stratigraphy of Britain, North America, and Australasia. This section concludes with a useful chapter on the development of surface relief, though more attention might have been given to modern work on isostasy and the structure of the Alps. Part 3 deals in two chapters with economic geology and geological surveying.

For elementary students the book thus presents within one pair of covers a remarkably complete survey of the subject, clearly written, and thoroughly well illustrated. It is, however, conventional, after the manner of older text-books. Had it been brought more authoritatively up-to-date, it could have been warmly recommended to British students. As it is, and taking into consideration the high price, it is not likely to be widely adopted except in Australasia, where it should prove particularly useful as a general textbook.

The World in the Past: a Popular Account of What it was Like and What it Contained. By B. Webster Smith. (The Wayside and Woodland Series.) Pp. xii+355+111 plates. (London and New York: Frederick Warne and Co., Ltd., 1926.) 10*s.* 6*d.* net.

This new volume of the "Wayside and Woodland Series" can scarcely be said to reach the usual standard of that admirable collection. It is extremely difficult to write a satisfactory popular account of geological history. The successful author of such a book must be an artist in prose, and he should wander at ease through his subject, presenting it in an attractive and persuasive form and in a friendly and authoritative way; above all he must not patronise the reader or indulge in 'journalistic bromides.'

Judged by the unwritten ideal, this attempt is not altogether a success. It has an old-fashioned flavour and is sprinkled with sentences that will offend the fastidious. As examples of the author's style which justify this criticism we may quote a sentence on p. 100: "Silurian times, the Age of Lime, were not so extensive, perhaps, as their predecessor, the Age of Mud; nevertheless, a million years' duration is the least that can be assigned to them"; and the description of Stegosaurus on Pl. 66: "The last word in Dinosaurian ugliness." Although betraying superficial knowledge, the book is not faulty in its facts. It contains many vivid descriptions of ancient animals and landscapes and is generally light and interesting in style. Many of the illustrations are excellent, and have not appeared before in geological books. More maps should have been included, and a saving in cost might have been effected by omitting some of the colour printing.

Palæontology: Invertebrate. By Henry Woods. (Cambridge Biological Series.) Sixth edition. Pp. vi+434. (Cambridge: At the University Press, 1926.) 10*s.* 6*d.* net.

It is a compliment to this useful and well-known book to find that after five years still another edition has been called for, despite the fact that during the life of the fifth edition it had to compete with rivals that had not previously entered the field. The book has now been revised, with special attention to the ammonites and corals, in connexion with which groups the author acknowledges assistance from Dr. L. F. Spath and

Dr. Stanley Smith respectively. Some new figures have also been added, and a useful feature is the guide to the literature of the subject. For more than thirty years this little book has been indispensable to the elementary student of invertebrate palæontology, and it remains, as before, clear, concise, and authoritative.

Economic Geology.

Clay and what we Get from it. By Alfred B. Searle. Pp. 178. (London: The Sheldon Press; New York and Toronto: The Macmillan Co., 1925.) 3*s.* 6*d.* net.

Except for a brief introductory account on the nature, mode of occurrence and origin of clays, and a closing chapter of quotations from prophets and poets, this book deals with the industrial applications of clay. It is, indeed, of special interest as showing to what a large extent clay figures as a thing of usefulness in human affairs. The author is full of knowledge of the subject, and in these interesting pages he has succeeded in conveying much of it, as well as some of his enthusiasm, to the reader. The book well deserves a place in the Popular Science series of the Sheldon Press.

Geological Survey, Scotland. The Economic Geology of the Ayrshire Coalfields. Area 1: Kilbirnie, Dalry and Kilmaurs. By J. E. Richey, G. W. Wilson and E. M. Anderson; with Contributions by C. H. Dinham. Pp. vi+91+2 plates. 2*s* 6*d*. net. Area 2: Kilmarnock Basin, including Stevenston, Kilwinning and Irvine. By E. M. Anderson; with Contributions by G. V. Wilson. Pp. vi+107+2 plates. 3*s*. net. Sheet 8: Vertical Sections illustrating the Ayrshire Coalfields, Areas 1 and 2. On the Scale of 40 ft. to 1 in. Arranged by E. M. Anderson and J. E. Richey. 2*s*. 6*d*. net. (Edinburgh and London: H.M. Stationery Office; Southampton: Ordnance Survey Office, 1925.)

These two volumes may be looked upon as the continuation of the series of memoirs on the coalfields of Scotland, a commencement on which was made some time ago with the Central Coalfield. The present volumes cover the greater part of the Ayrshire Coalfield, which for the purpose of description is divided into two areas, Area No. 1 comprising the main portion of the coalfields of central and northern Ayrshire, whilst Area No. 2 covers the southern portion of the coalfield, of which Kilmarnock may be looked upon as the centre.

The arrangement in both volumes is necessarily somewhat similar, commencing with an account of the general geological structure and then describing in detail each formation, beginning by the lowest known in the district. The coal seams are naturally described in much detail, but attention is also paid to the other minerals of economic importance, such as the ironstones, limestones, fireclay and other clays, building stones, sands, refractory materials, stones for road metal and other purposes. In the memoir upon Area No. 1 there is an appendix giving analyses of a number of these minerals of economic importance, and it is rather to be regretted that this excellent example has not been followed in the volume dealing with the second area.

It need scarcely be said that the work is admirably done, and that these two volumes contain a wealth of information which will be of the utmost value to the mines working in this important coalfield.

General Physics.

Marvels of Sound, Light and Electricity: an Introduction to some Physical Phenomena for Young Students. By Percival G. Bull. Pp. vii+221. (London: George Routledge and Sons, Ltd., n.d.) 6*s*. net.

This book, we are told in the preface, is not intended as a text-book, but is expected to fill the rôle of arousing such interest and enthusiasm as will induce the spare-time reader to proceed to a more detailed and systematic study of physics. If the reader is not an absolute beginner in physics, we are of opinion that the author has probably succeeded admirably in his task. But we are afraid that the opening pages of the book make too great a demand upon the absolute beginner. Such a reader must of necessity find the references to radiation, the spectrum, longitudinal waves, and the like (although these are explained in greater detail later), rather too difficult; which would be a great pity in view of the general excellence of the book once these first pages are passed.

The author begins with an explanation of the phenomena of wave motion and their application to sound. He then passes to the study of light and colour, and to the study of the invisible portion of the spectrum. The interpolation of a chapter on optical illusions is interesting and well done, but makes a break in the continuity of the theme. It is followed by a chapter on cathode and X-rays and radioactivity, after which the book is rounded off with a description of experiments with high-frequency electric currents and high-tension discharges. The style and production are both attractive, and we can confidently recommend a place for the book in all school libraries.

Elementary General Physical Science. By W. R. Jamieson. Pp. 63+88+147+x+16 plates. (Melbourne: Brown, Prior and Co. Pty., Ltd., 1926.) 8*s*. 6*d*. net.

We extend an unqualified welcome to this book. Published in Australia, it is the work of the senior chemistry master at the Scotch College, Melbourne. If it is to be taken as typical of the spirit that animates science teaching in the Commonwealth, then Australia has undoubtedly much to offer to British teachers of science in schools by way of example. If, on the other hand, it is not typical, then Mr. Jamieson is a pioneer worthy of every encouragement. He aims, in effect at the broadening of the approach to the study of science. This is a plea which has found increasing expression at the various conferences of the Science Masters' Association, and, so far as the physical sciences are concerned, the book under notice shows how well this can be done. Prof. Rivett, of the University of Melbourne, hints in a foreword at the advent of a companion volume on similar lines dealing with biological science, and we cordially hope this will speedily appear.

Want of space makes it impossible for us to go into details. We quote from the preface: "Without sacrificing in any degree the exactness and accuracy which are an essential feature of true science, the author has sought to inculcate ideas and express the spirit of science. . . . Broad treatment rather than minute and detailed study has been aimed at." Observing on the whole a historical sequence, the formal divisions of chemistry, physics, mechanics, and astronomy are all linked up and blended in the most interesting fashion; and if the shackles of tradition and examination make it difficult for the book to be adopted in many schools at home, we can at least contend that no teacher of science will be the poorer in ideas for the outlay which purchase of the book involves. I. B. H.

Quantum Theory.

Atomicity and Quanta: being the Rouse Ball Lecture delivered on May 11, 1925. By Dr. J. H. Jeans. Pp. 64. (Cambridge: At the University Press, 1926.) 2*s.* 6*d.* net.

Those who have at any time listened to Dr. Jeans are well aware of his skill and charm as a lecturer; these qualities were amply sufficient to make a success of a lecture which is on paper a little disappointing. Unfortunately, the necessities of a popular lecture on an abstruse subject inevitably lead to a certain superficiality, especially in dealing with its peculiar difficulties. For example, Dr. Jeans disposes in the usual way of the conflict between the quantum theory of radiation and the undulatory theory, by limiting the application of the two theories to different types of phenomena: the quantum theory applying to those arising from the interchange of energy between matter and radiation, and the undulatory theory to those connected with radiation travelling without interchange of energy with matter. When, however, he tries to bridge the gap, he does not adopt the almost mystical attitude towards this fundamental problem which many physicists have and may still feel obliged to maintain in spite of the advent of the new quantum mechanics, but resorts to arguments which seem unnecessarily crude. He emphasises the difficulty of obtaining reversibility in systems in which spherical waves play an important part, and suggests the introduction of 'advanced' as well as 'retarded' potentials in order to obtain it. The physical conception which this involves is, however, so difficult that it seems questionable whether any theory which requires it can ever be intellectually acceptable.

For those of Dr. Jeans's audience with the awakened mind and some familiarity with the subject, the lecture was excellent, vivid, with sufficient emphasis and balance of structure to make it striking and easily remembered. It must have given such a listener a clear-cut and manageable picture of much modern work that he had found puzzling before, and there will no doubt be many readers of the same type to whom the reprint will be profitable and congenial reading.

The Quantum Theory of the Atom. By George Birtwistle. Pp. xi+236. (Cambridge: At the University Press, 1926.) 15*s.* net.

The quantum theory in its applications to atomic physics has developed so rapidly, that a textbook, giving a fairly comprehensive and orderly account of the subject, has become an urgent necessity. Mr. Birtwistle has made a valiant and on the whole a very successful attempt to supply this need, and students of the subject will have cause to be grateful to him for his very clear exposition of it. The author has succeeded in compressing into his 233 pages of text a surprisingly complete account of the subject from the earliest speculations of Planck and Bohr to the latest work of Sommerfeld, Kramers and Heisenberg.

The treatment is entirely mathematical, and no attempt is made to discuss the physical and experimental basis of the subject. At the same time the author has, we imagine, had in mind the necessities of the student of pure physics, and very kindly and wisely has included chapters on those developments of classical mechanics—the Hamiltonian equations, the Hamilton-Jacobi equation, and Lagrangian methods—which, while they form the basis of much of the quantum mechanics, are unfortunately not part of the equipment of the average student of physics. These chapters add very considerably to the value of the book.

The writer of a textbook must adopt some kind of "Principle of Selection," and naturally some things are omitted which a reviewer might wish to have seen included. In particular Mr. Birtwistle passes over in, possibly discreet, silence the views of the ultra-modern school in which the quantum is handled as if it were a material particle; and, perhaps more seriously, the chapters on X-rays and γ-rays are somewhat inadequately treated. The author has, however, given us so much that is excellent that it would be unjust to complain because he has not included still more. We hope that the rapid exhaustion of this first edition will enable the author to keep the book as thoroughly abreast of the subject as it is at present.

Radio Communication.

Broadcast Reception in Theory and Practice. By J. Laurence Pritchard. Pp. xi+259. (London: Chapman and Hall, Ltd., 1926.) 8*s.* 6*d.* net.

During the last two or three years amateurs who are enthusiastic about radio communication have attempted, in some cases successfully, to increase their knowledge by reading standard books on the subject. Probably they began by constructing a radio set from given instructions. Wanting to learn the theory, many found that the ordinary books made too great a demand on their knowledge of the principles of electricity. This book has been written for their use. Formulæ are given but not proved. Confidence in them, however, is obtained by following out the working of numerical examples. The experimenter is then told how to construct his own coils, condensers and resistances, emphasis being laid on important practical details.

A useful chapter is given on how to detect and remedy faults in a receiving set. It is pointed out that the most probable seat of the trouble is the high-tension battery. This is indicated when the signal strength becomes weak, accompanied by crackling noises similar to atmospherics but more persistent. This is generally due to the H.T. battery becoming exhausted and internal disintegration being set up. The zinc containers of the cells get eaten through, soldered intercell connexions become affected, and gas is evolved which makes its way through the pitch or other filling used. The cells quickly polarise and the voltage falls. If a high-resistance voltmeter be available this fault is readily discovered. But if not, it is necessary to substitute a new battery for the suspected battery to find out if it is at fault. External connecting wires are sometimes broken inside their insulated coverings. Search should be made for this fault. Telephones occasionally give trouble. Every pair of telephones should give a healthy click on being connected to a battery composed of a penny and a shilling separated by a piece of wet tissue paper. If they are defective they should be sent to the makers for repair. Trouble is sometimes experienced by valve legs of the split type failing to make good contact. The remedy is simply to open the slits slightly by the aid of a knife.

Loud Speakers, their Construction, Performance and Maintenance: a Practical Handbook for Wireless Manufacturers and Traders and for all Wireless Amateurs; containing Notes on the Selection of a Loud Speaker and on the Detection and Remedying of Faults. By C. M. R. Balbi. Pp. xv+96. (London: Sir Isaac Pitman and Sons, Ltd., 1926.) 3s. 6d. net.

THE science of sound reproduction by means of a loud speaker is one of ever-growing interest and importance. This little book gives a brief but fairly complete résumé of the subject. The various forms of loud speaker can be classified under three main heads. The first class may be called electro-magnetic. In this class are the well-known Amplion, Brown, Western Electric and Lumière loud speakers In the second class are those which utilise the phenomena of friction or of the electrostatic attractions produced at the face of semi-conductors. The Frenophone is an example of the former and the Joh[illegible] Rahbek of the latter. In the third class are included many which depend on curious physical phenomena. In this class are the arc loud speaker invented by Duddell, the air-blast, the jet of water, the piezo electric, the crystal, the hot wire, the thermophone and the condenser loud speakers The mere enumeration shows the variety of physical principles employed all leading when applied to very similar results.

A good description is given of the Western Electric public address system It is now possible for a public speaker to address a million people at once, and the speaker's voice can be plainly heard at a distance of 1000 feet. The electric power required for these installations is about two kilowatts. With very large assemblies it has been found necessary to provide observing stations at various points in the audience. The observers stationed at these points communicate with the operator by portable telephone sets. A chapter of advice to those intending to purchase loud speakers concludes the volume. So many variables, such as the power and distance of the broadcasting station, have to be taken into consideration that it is only possible to give vague advice. Notes on various types of commercial loud speakers are given, but they would have been more useful if less praise and more criticism had been given.

The Radio Press Year Book 1926: the Wireless Book of Reference Edited by John Scott-Taggart and Percy W. Harris. Pp. 169. (London: Radio Press, Ltd., 1926) 1s. 6d.

MUCH interesting information is given in this little book which will be of value to those desirous of improving their radio-receiving sets. Short sections are contributed by well-known radio engineers. P. W. Harris, for example, compares American and English radio conditions.

As a matter of history, the first daily broadcasting of a programme was made from the well-known K D K A station at East Pittsburgh. In Great Britain Mr. Godfrey Isaacs and the Marconi Company broadcast concerts from Marconi House before the B.B.C. was formed.

In the early days, the Americans were greatly troubled by what they called 'squealing' receivers. To-day, thanks mainly to neutralised high-frequency couplings, the receivers sold in the United States are strictly non-radiating, and it is possible to listen to distant stations, even from the most crowded districts in New York and Chicago, without hearing the faintest trace of an oscillation. The U.S Government allots definite wave-lengths to the broadcasters and makes them adhere to them very closely. One regulation which sounds curious to British readers is the prohibition of what is called 'canned music,' that is, the music made by gramophone records and player pianos. A useful regulation by the U.S. Government which might be copied with advantage in Europe is that a certified operator is on watch during broadcasting hours, so that in the event of an S.O.S. signal being heard, the broadcasting transmission may be stopped. The section on how to select a valve is a useful one. Although many purchase dull-emitter and bright-emitter valves and talk glibly about them, yet few have any accurate knowledge of their main characteristics. Lists are given of practically all the valves on the market, and the values of their filament ratings, voltages, internal impedances, and amplification ratios are all given.

Many characteristic diagrams are given to illustrate their working. The list of amateur call signs now occupies 30 pages, and there is a long list of radio societies.

The Motor Car and its Engine.

The Book of the Light Car. By E. T. Brown. Pp. vii+155+12 plates. (London: Chapman and Hall, Ltd., 1926.) 7s. 6d. net.

THE modern light car has been so far perfected and the motor industry so well organised that it is possible and common for persons completely innocent of mechanical knowledge to motor with satisfaction and safety. Many readers of NATURE even may fall within this class and will, nevertheless, feel curious about the construction and working of what is so easily controlled from the driving-seat. For such, Mr. Brown has written clearly in a book well paragraphed and indexed, so that answers to most of the inevitable questions can be turned up in a moment. Here and there the fastidious may be tempted to query the scientific precision of statement or the literary elegance of motoring jargon, but such will probably be in the minority. Again, in places mention is made of certain important parts such as the 'accelerator' and 'throttle,' without any explanation of their construction and mode of operation, but such omissions do not seem numerous, and the book may be commended to those for whom it is intended.

H. J. H.

The Economics of Carburetting and Manifolding: Vaporising and Distributing Liquid Fuel in a Motor Car Engine. By Robert W. A. Brewer. Pp. vii + 176. (London: Crosby Lockwood and Son, 1926.) 12*s.* 6*d.* net.

This book deals with a problem which is of interest to both motor spirit producers and motor engineers. The great increase in the requirements of fuel for internal combustion engines during the past decade has necessitated the production of the maximum quantity of motor spirit from a given quantity of crude material. One method by which this is being effected is by raising the upper limit of the distillation range of the motor spirit fraction. The high boiling constituents, which are thereby included, have rendered it more difficult to vaporise the fuel completely. The author professes to deal with the problem of using such fuels in motor car engines satisfactorily and economically under all conditions of operation, and the book supplements the author's book on "Carburation," where fuels, principally of the more volatile nature, are examined.

The problem is attacked chiefly from the point of view of the design of the induction system (inlet manifold), and various interesting reports and papers which have been issued by the Bureau of Mines in the United States, Society of Automotive Engineers, and others are summarised. A brief account of the author's work on the design of inlet manifolds and descriptions of other systems are also given, and a chapter is devoted to the problem of the dilution of the crank case oil.

The book would appear to be primarily intended for motor engineers. In attempting to make clear to the technical reader the scientific principles involved in vaporising and distributing liquid fuels in motor car engines, the author has been led to use terms which are vague and undefined. The various units used are also somewhat confusing. The book, however, is useful in bringing to the notice of motor users and designers the problem of the efficient utilisation of the high boiling motor spirits which are now on the market.

Miscellaneous.

Recent Advances in Physical and Inorganic Chemistry. By Prof. Alfred W. Stewart. Fifth edition. Pp. [illegible]i + 312 + 6 plates. (London: Longmans, Green and Co., Ltd., 1926.) 18*s.* net.

Prof. Stewart's excellent and useful book is too well known to make any lengthy notice of it necessary. The present edition has all the good qualities of its predecessors, and keeps the student always stationed at the growing point of physical chemical knowledge. Only five chapters have survived from the 1920 edition, and a dozen new chapters have been written for this edition, dealing with hafnium, the isobares, the results of mass-spectrography, the segregation of isotopes, atomic structure, active hydrogen, new hydrides, intensive drying, and Tesla-luminescence spectra. On the whole, the discussion of these various topics has been very well done, and the general student of chemistry is fortunate in having within comparatively small compass all that he requires in order to understand the present position of knowledge in the respective fields.

Palgrave's Dictionary of Political Economy. Edited by Henry Higgs. Vol. 3: N-Z. Pp. xxiii + 849. (London: Macmillan and Co., Ltd., 1926.) 36*s.* net.

The editor and the publishers are to be congratulated on the completion, by the appearance of the third and last volume, of the new edition of Palgrave's standard work. Sixteen years have elapsed since the publication of the first edition; the present edition may be expected to serve the needs of students of economics for as long a period.

The third volume reaches the high standard of excellence to which the first two attained; like those, it reprints the articles as they stood in the original edition and supplements them by others either entirely new or in continuation of old themes. Thus the account of the National Debt is brought down to the year 1923; and problems of recent growth and importance are given ample and authoritative consideration. Social legislation in all its branches is brought up-to-date; there is a very useful statement on the Tariff Reform movement; the article on Socialism is full and instructive; and it is a sign of the times that the appendix contains an article on "The Need of Trained Inquirers into Social Conditions."

An outstanding feature of the volume is its provision of adequate biographies of both British and foreign economists, and not the least useful portion of these is the bibliography attached to each. Indeed, the book-lists throughout the work, like the detailed index at the end, will be found of exceeding great value.

Tin and the Tin Industry: the Metal History, Character and Application. By A. H. Mundey. (Pitman's Common Commodities and Industries Series.) Pp. xiii + 130. (London: Sir Isaac Pitman and Sons, Ltd.; n.d.) 3*s.* net.

The author of this book has succeeded in setting out, in inexpensive and handy form, a concise account of the numerous industrial applications of tin and its alloys. Very little is said about the mineralogy, geology and mining of tin ores, and smelting is referred to very briefly. The book is well illustrated, and should prove helpful to those interested in the commercial aspects of this very useful metal.

The States of Aggregation: the Changes in the State of Matter in their Dependence upon Pressure and Temperature. By Gustav Tammann. Authorised Translation from the second German edition by Dr. Robert Franklin Mehl. Pp. xi + 297. (London, Bombay and Sydney: Constable and Co., Ltd., 1926.) 24*s.* net.

Students and others interested in the heterogeneous equilibria of one-component systems will welcome this translation of Tammann's excellent work "Aggregatzustände," a notice of which appeared in these columns. It suffices to say that Dr. Mehl has produced an accurate and smoothly reading translation, and has thereby made the work available to an extended circle of readers.

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